SCIENCE

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FRIDAY, NOVEMBER 24, 1899.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

REPORT ON THE NAVAL OBSERVATORY.

WE print on another page of our present issue the report of the Board of Visitors to the Naval Observatory, made on October 2d. Most astronomers will, we believe, agree with us that the work of the Board has been well done in several vital points. It is true that many details are left to be settled and much friction may be produced in putting the plan into operation. But, in any case, much will have been gained. The good features of the report are these:

We have for the first time what may be called an official admission that the Observatory must be reorganized on a civilian basis, made under such auspices and in such a way as to command attention. In stating the case all disagreeable details are avoided and, so far as possible, conclusions are intimated rather than expressed. Yet every point is so stated that no mistake of interpretation by the careful reader is possible. The optimistic impression always so agreeable to entertain, that, however weak may have been the administration from time to time in the past, it is now all right, is guarded against by stating that the scope of the remarks is not limited to the present time, but covers almost the

entire period of the existence of the Observatory. The hope is expressed that under an improved system the Observatory will attain and hold that high standing which should be expected of it, thus clearly intimating that this high standing does not belong to the past or present. What will happen if something effective is not done is stated very plainly. At the same time there is no reflection on any person or any authority.

The second feature of the proposed plan is the appointment of a Board of Visitors so organized as to secure efficiency. The great difficulty in the past has been that, although attempts have from time to time been made to improve the administration, there has been no authority to decide and report whether any real improvement had been effected. The proposed Board, containing as it does six astronomers of high professional standing, has to report at least annually on the efficiency with which the scientific work is prosecuted. If this work is in any way neglected, such a board will surely discover the reason and report what measures are necessary to insure success.

The third feature to which we refer guards against a result which has more than any other cause tended to weaken the efforts made in favor of reform. The fear has constantly been held forth that, in the event of a civilian organization being introduced, appointments would be made through political influence. This has been one of the favorite arguments against reform. The plan guards against this, by having the principal officers recommended to the appointing power by the Board of Visitors. One feature of the proceedings in making such nominations, shows a remarkably clear insight into the conditions of the case:

"The recommendations shall be determined only by a majority vote of the members present at a regularly called meeting of the Board in the city of Washington."

The great difficulty in the way of making the best nomination lies in the absence of discussion of the merits of the several candidates. We doubt not that, at such a meeting of the Board, the merits of every possible candidate would be discussed in the freest and fullest manner. In this way the best attainable result will be reached.

Minor defects in the report could be pointed out; but it might show a failure to appreciate the general excellence of the plan to consider these defects in detail. Two, however, may be mentioned. The powers of the proposed astronomical director are not defined. The question is thus left open whether the present system in which the director has all the responsibility for the astronomical work and no real power is to be continued.

Only one nomination to each office is provided for. This may be objected to as not leaving sufficient discretion to the appointing power. The French plan, on which two nominations to each office are made, the order of choice being indicated, seems to us preferable. The number might even be extended to three. As a general rule it might be expected that the appointing power would select the candidate pre-

ferred. At the same time circumstances might render the selection of the second advisable.

The unanimity of the report and the good feeling which has characterized the whole movement is one of the most encouraging features of the case. We trust that the plan will be enacted into law by Congress at its coming session.

REPORT OF THE BOARD OF VISITORS TO THE UNITED STATES NAVAL OBSERVATORY, OCTOBER 2, 1899.

WASHINGTON, D. C.,
October 2, 1899.

HON. JOHN D. LONG, *Secy. of the Navy.*

SIR: In compliance with the request contained in your letter of June 30, 1899, the undersigned have acted as a Board of Visitors to the United States Naval Observatory in Washington and now submit their report, including subdivisions as follows:

I. Recommendations of the Board of Visitors.
II. Circumstances leading to the appointment of the Board of Visitors.
III. Cost of the Observatory.
IV. Comparison with other Observatories.
V. Present condition and methods of observatory work and the delay in printing its results.
VI. Historical sketch of the Observatory.
VII. Minutes of the proceedings of the Board of Visitors.
VIII. Appendix.

The several portions of the report were put in form by the astronomers who are members of the Board. The recommendations are made unanimously.

Very respectfully,
WM. E. CHANDLER.
A. G. DAYTON,
EDWARD C. PICKERING.
GEO. C. COMSTOCK,
GEORGE E. HALE.

RECOMMENDATIONS OF THE BOARD OF VISITORS.

In accordance with the instructions contained in the following letter all the members of the Board of Visitors to the United States Naval Observatory therein named, met at the Observatory in Washington on Friday, June 30, 1899, and organized by the selection of William E. Chandler as Chairman, and George C. Comstock as Secretary.

NAVY DEPARTMENT,
Washington, June 30, 1899.

GENTLEMEN: In accordance with previous correspondence and oral conversations, you are hereby requested to act as a Board of Visitors at the United States Naval Observatory in Washington, convening there to-day, and to proceed to examine into the condition of that institution and to report to me your conclusions and recommendations.

Very respectfully,
JOHN D. LONG,
Secretary.

Hon. William E. Chandler,
Hon. Alston G. Dayton,
Professor Edward C. Pickering,
Professor George C. Comstock, and
Professor George E. Hale.

Captain Charles H. Davis, U. S. N., Superintendent of the Naval Observatory, presented to the Board an informal statement of circumstances leading to the appointment of the Board of Visitors and submitted correspondence relating thereto (Appendix, Exhibit A) and to a proposed reorganization of the Observatory (Appendix, Exhibit B). He also placed before the Board a list of professors of mathematics upon the active list of the navy (Appendix, Exhibit C) from which corps the staff of the observatory is largely drawn and a list of all persons performing duty at the observatory with their respective ranks (Appendix, Exhibit D).

At the request of Messrs. Chandler and Dayton there was submitted to the Board, by its other members, the correspondence conducted by them, as a Committee of the Second Annual Conference of Astronomers and Astrophysicists, for the purpose of obtain-

ing the views of American astronomers and physicists upon the organization and work of the Naval Observatory. Mr. Pickering submitted to the Board a statement regarding correspondence on the same subject conducted by a Committee of the American Association for the Advancement of Science.

In view of the facts brought before the Board at its several sessions and after the best consideration which it has been able to give to the subject, the Board of Visitors reports and recommends as follows:

The Naval Observatory, which was originally established as a scientific bureau, auxiliary to the needs of the naval service, has become through half a century of growth and through the expenditure of large sums of money, as authorized by law, an astronomical observatory of the first rank in respect of buildings, instruments and equipments. But by far the larger and more valuable part of its equipment has little or no reference to any direct requirement of the naval service and its existence can be justified only on the ground that Congress has intended to establish and maintain a national astronomical observatory. Under these changed circumstances its continued connection with the Navy Department has seemed to many of those whose views have been submitted to the Board of Visitors, illogical and undesirable. In view, however, of the absence of a national university, a Department of Science and Industries, or other department or bureau of the government especially suited to the conduct of such scientific work, and in view of the diversity of opinion among American astronomers upon the question to which existing department the observatory could be wisely transferred, we believe it to be inexpedient for us at the present time to further consider the subject of such transfer.

With reference to the organization of the Observatory under naval administration, the Board of Visitors disapproves of those parts of the 'Proposed Organization of Naval Observatory' (Appendix, Exhibit B), submitted under date of September 7, 1897, by 'F. E. Chadwick, Chief of Bureau of Equipment and C. H. Davis, Superintendent United States Naval Observatory,' which requires the establishment of a formal observatory council with nominal functions and which by omission practically abolish the office of Astronomical director. We are by no means objecting to the assembling in conference of the astronomers engaged in the observatory work, but the proposed transfer of duties and responsibilities from a single director to a committee of five appears to us a step in the wrong direction; and when, as under the proposed scheme, an absolute power of veto upon all action by the council is lodged in the hands of one of its members, the usefulness of the body seems to approach the vanishing point. In the history of observatories we have been unable to find a case of successful administration without a competent astronomer in immediate supervision of the work, and we believe that the ideal conditions for the successful administration of an astronomical observatory are most nearly realized when a professional astronomer is made the responsible director of the work. This system which is adopted in every great national observatory, the Board of Visitors believes to be the one best suited to secure the astronomical efficiency of the Naval Observatory.

If the naval observatory as a shore-station charged with the performance of certain functions assumed to have a relation to the navy is to continue under the command of a line officer, we recommend that the astronomical staff of the Naval Observatory shall consist of an Astronomical Director, four astronomers, three assistant astronomers and such computers and other minor officers as may be provided by law. The Astronomical Directors and astronomers, whether professors of mathematics

or taken from civil life, and the assistant astronomers, should be appointed by the President, by and with the advice and consent of the Senate, to hold their offices until their successors are appointed.

The Nautical Almanac office, which was formerly a distinct bureau, is now administered by departmental regulations as a part of the Naval Observatory, and it appears from the evidence submitted to the Board of Visitors that the successful administration of the Observatory is much impeded by reason of imposing upon its astronomical director, the duties of Director of the Nautical Almanac. Each of these offices furnishes abundant employment for the entire time of an able astronomer, and we therefore recommend that there shall be a Director of the Nautical Almanac appointed by the President, by and with the advice and consent of the Senate, to hold office until his successor is appointed.

We also recommend that provision be made for the continuation of the admirable series of memoirs published under the title 'Professional Papers of the American Ephemeris and Nautical Almanac.'

A criticism, frequently and forcibly urged against the administration of the Naval Observatory, not limited to the present time, but covering almost the entire period of its existence, is that its astronomical work has not been prosecuted with that vigor and continuity of purpose which should be shown in a national observatory. The possibility of conducting well planned researches with unvarying regularity over long series of years should constitute the great advantage of a national observatory, an advantage which is not fully realized in the history of the Naval Observatory, where each principal astronomer seems to have been left to choose his own line of work and to alter it from time to time or abandon it. This is perhaps inevitable in a system which places at the head of an observatory an officer who is not a technical expert in astronomical work; and therefore in order to secure continuity in the prosecution of work well chosen and coördinated with that of other observatories, and also to obtain for the observatory and the department advice and criticism which shall be both disinterested and responsible, we recommend the establishment of a permanent Board of Visitors substantially as follows:

There shall be appointed by the President, from persons not officers of the United States, a board of nine visitors to the Naval Observatory, six to be astronomers of high professional standing, and three to be eminent citizens of the United States. Appointments to this Board shall be made for periods of three years, but provision shall be made by initial appointments for shorter terms so that two astronomers and one member of the Board not an astronomer shall retire in each year. Members of this Board shall serve without compensation, but the Secretary of the Navy shall pay the actual expenses necessarily incurred by members of the Board in the discharge of such duties as are assigned them by the Secretary of the Navy, or are otherwise imposed upon them. The Board of Visitors shall make an annual visitation to the Naval Observatory at a date to be determined by the Secretary of the Navy and may make such other visitations, not exceeding two in number annually, by the full Board or by a duly appointed committee, as may be deemed needful or expedient by a majority of the Board.

The Board of Visitors shall report to the Secretary of the Navy at least once in each year the result of its examinations of the Naval Observatory as respects the condition of buildings, instruments and apparatus, and the efficiency with which its scientific work is prosecuted. The Board of Visitors shall prepare and submit to the Secretary of the Navy regulations prescribing the

scope of the astronomical and other researches of the Naval Observatory and the duties of its staff with reference thereto. When appointments or details are to be made to the office of Astronomical Director, Director of the Nautical Almanac, astronomer or assistant astronomer in the Naval Observatory, the Board of Visitors may recommend to the Secretary of the Navy suitable persons to fill such offices, but such recommendations shall be determined only by a majority vote of the members present at a regularly called meeting of the Board held in the city of Washington.

Special attention is at this point called to the fact that the appointment of a Board of Visitors to the Naval Observatory was recommended by Secretary Tracy in 1891, has been repeatedly urged by Superintendents of the Observatory, and is renewed by F. E. Chadwick, Chief of Bureau of Equipment, and C. H. Davis, Superintendent United States Naval Observatory, in the 'Proposed Organization of a Naval Observatory,' dated September 7, 1897 (Appendix, Exhibit B). The duties of the Board, as defined by these naval officers, would be in part as follows: "It lays down the general course of policy to be pursued for the coming year, including printing and publication of observations; fixes the estimates for the astronomical departments; nominates to fill vacancies in the astronomical staff (either by appointment or promotion); recommends as to repairs and acquisitions of new instruments.

If a permanent Board of Visitors as above recommended is established as a part of the administration of the Naval Observatory, it is evident that to it should be committed these questions of policy to be pursued in the conduct of the observatory which are contained in the memorandum (Appendix, Exhibit B), submitted to the present Board by the Secretary of the Navy, under date of June 28, 1899. We therefore abstain from specific recommendations upon these subjects, many of which indeed call for a more prolonged and minute study of the situation than the members of the present Board have been able to give to it.

We heartily endorse the recommendation contained in your report as Secretary of the Navy for the year 1897, that "the statute authorizing the appointment of professors of mathematics be so amended that without disturbing those who now hold office, which would be unjust to them, no further appointments shall be made" to the staff of Naval Observatory (Appendix, Exhibit L). In addition to the reasons for this action which are urged by you in that report, we submit for your consideration, that the conditions under which astronomical work is done are so different from those which obtain in the naval service, that a fixed tenure of office with the certainty of a retiring pension in no way dependent upon the zeal or efficiency with which service has been rendered, may easily produce diminished diligence and a purely perfunctory discharge of duties. A more serious evil of the existing system of naval commissions for astronomers, and one which has been forcibly exemplified within the past decade, is the compulsory retirement at the age of sixty-two of astronomers, who are then in the maturity of their powers, and who under civilian appointments would continue to render to the observatory a service of undiminished efficiency, which they now transfer to other institutions. The reasons which impel the retirement of a naval officer from active service upon attaining a fixed age have no application in the case of an astronomer, and he should be placed upon the same footing with other officers of the government performing strictly civilian duties.

If astronomers are appointed to the Naval Observatory from civil life to succeed retiring professors of mathematics, the salaries provided should be sufficient,

as recommended by you in that report for 1897, "to make up for the refusal to them of the privilege of retirement, and also to secure men of high scientific attainments adequate to the demands of one of the most capable observatories in the world." To secure the services of the ablest astronomers the salaries provided should be slightly larger than those paid in the higher class of university observatories and account should be taken of the fact that university vacations are much longer than leaves of absence from the public service. The Board of Visitors recommends the following as a schedule of salaries which could be expected to attract astronomers of the class desired :

Astronomical Director	$6000.
Director of Nautical Almanac	5000.
First Astronomer	4000.
Second "	3600.
Third "	3200.
Fourth "	2800.
First Assistant Astronomer	2400.
Second " "	2200.
Third " "	2000.

The experience of every great observatory shows that the efficiency of its staff is materially increased by the provision of quarters near the observing rooms for those persons who are engaged in work by night, and we recommend that there should be quarters provided upon the observatory grounds for all members of the astronomical staff regularly assigned to night work.

In concluding its recommendations, the Board of Visitors wishes earnestly to urge upon your consideration the necessity of making a success of the movement which you have begun, in order to improve the condition of the Naval Observatory, and to make its administration satisfactory to the great body of the astronomers of the country and to the public.

Some of our recommendations, if they meet your approval, can be carried into effect by departmental action, but the changes which we regard as vital can only be obtained through legislation by Congress. If such legislation is withheld, the continuance of present conditions is sure to result in a renewed, persistent, and possibly acrimonious demand for the removal of the observatory from naval control. If, however, the legislation is enacted, and the improved system is given a fair trial, unquestionably much improvement will result, and it is not improbable that the observatory will attain and hold that high standing in the scientific world which should be required of such an institution.

To help bring about such a desirable consummation, we have complied with your request, although not made in pursuance of any law, that we should visit and investigate the observatory, and we have recommended specific measures which we hope will lead to those reforms in administration which are imperatively necessary if the observatory is to receive and retain the confidence and support of the astronomers and scientists of the world.

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*ADDRESS OF THE PRESIDENT OF THE GEOGRAPHICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

I.

IN his opening address to the members of the British Association at the Ipswich meeting, the President cast a retrospective glance at the progress that had taken place in the several branches of scientific inquiry from the time of the formation of the Association in 1831 down to 1895, the year in which were published the last two of the fifty volumes of reports containing the scientific results of the voyage of H.M.S. *Challenger*. In that very able and detailed review there is no reference whatever to the work of the numerous expeditions which had been fitted out by this and other countries for the exploration of the depths

* Dover, 1899.

of the sea, nor is there any mention of the great advance in our knowledge of the ocean during the period of sixty-five years then under consideration. This omission may be accounted for by the fact that, at the time of the formation of the British Association, knowledge concerning the ocean was, literally speaking, superficial. The study of marine phenomena had hitherto been almost entirely limited to the surface and shallow waters of the ocean, to the survey of coasts and of oceanic routes directly useful for commercial purposes. Down to that time there had been no systematic attempts to ascertain the physical and biological conditions of those regions of the earth's surface covered by the deeper waters of the ocean; indeed, most of the apparatus necessary for such investigations had not yet been invented.

The difficulties connected with the exploration of the greater depths of the sea arise principally from the fact that, in the majority of cases, the observations are necessarily indirect. At the surface of the ocean direct observation is possible, but our knowledge of the conditions prevailing in deep water, and of all that is there taking place, is almost wholly dependent on the correct working of instruments, the action of which at the critical moment is hidden from sight.

It was the desire to establish telegraphic communication between Europe and America that gave the first direct impulse to the scientific exploration of the great ocean-basins, and at the present day the survey of new cable routes still yields each year a large amount of accurate knowledge regarding the floor of the ocean. Immediately before the *Challenger* Expedition there was a marked improvement in all the apparatus used in marine investigations, and thus during the *Challenger* Expedition the great ocean-basins were for the first time systematically and successfully explored. This expedition, which lasted for nearly four years, was successful beyond the expectations of its promoters, and opened out a new era in the study of oceanography. A great many sciences were enriched by a grand accumulation of new facts. Large collections were sent and brought home, and were subsequently described by specialists belonging to almost every civilized nation. Since the *Challenger* Expedition there has been almost a revolution in the methods employed in deep-sea observations. The most profound abysses of the ocean are now being everywhere examined by sailors and scientific men with increasing precision, rapidity, and success.

The recognition of oceanography as a distinct branch of science may be said to date from the commencement of the *Challenger* investigations. The fuller knowledge we now possess about all oceanic phenomena has had a great modifying influence on many general conceptions as to the nature and extent of those changes which the crust of the earth is now undergoing and has undergone in past geological times. Our knowledge of the ocean is still very incomplete. So much has, however, already been acquired that the historian will, in all probability, point to the oceanographical discoveries during the past forty years as the most important addition to the natural knowledge of our planet since the great geographical voyages associated with the names of Columbus, Da Gama, and Magellan, at the end of the fifteenth and the beginning of the sixteenth centuries.

It is not my intention on this occasion to attempt anything like a general review of the present state of oceanographic science. But, as nearly all the samples of marine deposits collected during the past thirty years have passed through my hands, I shall endeavor briefly to point out what, in general, their detailed examination teaches with respect to the present condi-

tion of the floor of the ocean, and I will thereafter indicate what appears to me to be the bearing of some of these results on speculations as to the evolution of the existing surface features of our planet.

Depth of the Ocean.

All measurements of depth, by which we ascertain the relief of that part of the earth's crust covered by water, are referred to the sea-surface; the measurements of height on the land are likewise referred to sea-level. It is admitted that the ocean has a very complicated undulating surface, in consequence of the attraction which the heterogeneous and elevated portions of the lithosphere exercise on the liquid hydrosphere. In the opinion of geodesists the geoid may in some places depart from the figure of the spheroid by 1,000 feet. Still it is not likely that this surface of the geoid departs so widely from the mean ellipsoidal form as to introduce a great error into our estimates of the elevations and depressions on the surface of the lithosphere.

The soundings over the water-surface of the globe have accumulated at a rapid rate during the past fifty years. In the shallow water, where it is necessary to know the depth for purposes of navigation, the soundings may now be spoken of as innumerable; the 100-fathom line surrounding the land can therefore often be drawn in with much exactness. Compared with this shallow-water region, the soundings in deep water beyond the 100-fathom line are much less numerous; each year, however, there are large additions to our knowledge. Within the last decade over ten thousand deep soundings have been taken by British ships alone. The deep soundings are scattered over the different ocean-basins in varying proportions, being now most numerous in the North Atlantic and South-west Pacific, and in these two regions the contour-lines of depth may be drawn in with greater confidence than in the other divisions of the great ocean-basins. It may be pointed out that 659 soundings taken quite recently during cable surveys in the North Atlantic, although much closer together than is usually the case, and yielding much detailed information to cable engineers, have, from a general point of view, necessitated but little alteration in the contour-lines drawn on the *Challenger* bathymetrical maps published in 1895. Again, the recent soundings of the German s.s. *Valdivia* in the Atlantic, Indian, and Southern Oceans have not caused very great alteration in the positions of the contour-lines on the *Challenger* maps, if we except one occasion in the South Atlantic when a depth of 2,000 fathoms was expected and the sounding machine recorded a depth of only 536 fathoms, and again in the great Southern Ocean when depths exceeding 3,000 fathoms were obtained in a region where the contour-lines indicated between 1,000 and 2,000 fathoms. This latter discovery suggests that the great depth recorded by Ross to the southeast of South Georgia may not be very far from the truth.

I have redrawn the several contour-lines of depth in the great ocean-basins, after careful consideration of the most recent data, and these may now be regarded as a somewhat close approximation to the actual state of matters, with the possible exception of the great Southern and Antarctic Oceans, where there are relatively few soundings, but where the projected antarctic expeditions should soon be at work. On the whole, it may be said that the general tendency of recent soundings is to extend the area with depths greater than 1,000 fathoms, and to show that numerous volcanic cones rise from the general level of the floor of the ocean-basins up to various levels beneath the sea-surface.

The areas marked out by the contour-lines of depth are now estimated as follows:

Between the shore and		100 fms.,	7,000,000	sq.	geo.	m.	(or	7%	of the	sea-bed)
"	100	" 1,000 "	10,000,000	"	"		(or	10%	"	")
"	1,000	" 2,000 "	22,000,000	"	"		(or	21%	"	")
"	2,000	" 3,000 "	57,000,000	"	"		(or	55%	"	")
Over 3,000 fathoms,			7,000,000	"	"		(or	7%	"	")
			103,000,000	sq.	geo.	m.		100	per cent.	

From these results it appears that considerably more than half of the sea-floor lies at a depth exceeding 2,000 fathoms, or over two geographical miles. It is interesting to note that the area within the 100-fathom line occupies 7,000,000 square geographical miles, whereas the area occupied by the next succeeding 900 fathoms (viz., between 100 and 1,000 fathoms) occupies only 10,000,000 square geographical miles. This points to a relatively rapid descent of the sea-floor along the continental slopes between 100 and 1,000 fathoms, and, therefore, confirms the results gained by actual soundings in this region, many of which indicate steep inclines or even perpendicular cliffs. Not only are the continental slopes the seat of many deposit-slips and seismic disturbances, but Mr. Benest has given good reasons for believing that underground rivers sometimes enter the sea at depths beyond 100 fathoms, and there bring about sudden changes in deep water. Again, the relatively large area covered by the continental shelf between the shore-line and 100 fathoms points to the wearing away of the land by current and wave action.

On the *Challenger* charts all areas where the depth exceeds 3,000 fathoms have been called 'Deeps,' and distinctive names have been conferred upon them. Forty-three such depressions are now known, and the positions of these are shown on the map here exhibited; twenty-four are situated in the Pacific Ocean, three in the Indian Ocean, fifteen in the Atlantic Ocean and one in the Southern and Antarctic Oceans. The area occupied by these thirty-nine deeps is estimated at 7,152,000 square geographical miles, or about 7 per cent. of the total water-surface of the globe. Within these deeps over 250 soundings have been recorded, of which twenty-four exceed 4,000 fathoms, including three exceeding 5,000 fathoms.

Depths exceeding 4,000 fathoms (or four geographical miles) have been recorded within eight of the deeps, viz., in the North Atlantic within the Nares Deep; in the Antarctic within the Ross Deep; in the Banda Sea within the Weber Deep; in the North Pacific within the Challenger, Tuscarora and Supau Deeps, and in the South Pacific within the Aldrich and Richards Deeps. Depths exceeding 5,000 fathoms have been hitherto recorded only within the Aldrich Deep of the South Pacific, to the east of the Kermadecs and Friendly Islands, where the greatest depth is 5,155 fathoms, or 530 feet more than five geographical miles, being about 2,000 feet more below the level of the sea than the summit of Mount Everest in the Himalayas is above it. The levels on the surface of the lithosphere thus oscillate between the limits of about ten geographical miles (more than eighteen kilometers).

Temperature of the Ocean-Floor.

Our knowledge of the temperature on the floor of the ocean is derived from observations in the layers of water immediately above the bottom by means of deep-sea thermometers, from the electric resistance of telegraph cables resting on the bed of the great ocean-basins, and from the temperature of large masses of mud and ooze brought up by the dredge from great

depths. These observations are now sufficiently numerous to permit of some general statements as to the distribution of temperature over the bottom of the great oceans.

All the temperatures recorded up to the present time in the sub-surface waters of the open ocean indicate that at a depth of about 100 fathoms seasonal variation of temperature disappears. Beyond that depth there is a constant, or nearly constant, temperature at any one place throughout the year. In some special positions, and under some peculiar conditions, a lateral shifting of large bodies of water takes place on the floor of the ocean at depths greater than 100 fathoms. This phenomenon has been well illustrated by Professor Libbey off the east coast of North America, where the Gulf Stream and Labrador Current run side by side in opposite directions. This lateral shifting cannot, however, be called seasonal, for it appears to be effected by violent storms or strong off-shore winds bringing up colder water from considerable depths to supply the place of the surface drift, so that the colder water covers stretches of the ocean's bed which under normal conditions are overlaid by warmer strata of water. Sudden changes of temperature like these cause the destruction of innumerable marine animals, and produce very marked peculiarities in the deposits over the areas thus affected.

It is estimated that 92 per cent. of the entire sea-floor has a temperature lower than 40° F. This is in striking contrast to the temperature prevailing at the surface of the ocean, only 16 per cent. of which has a mean temperature under 40° F. The temperature over nearly the whole of the floor of the Indian Ocean in deep water is under 35° F. A similar temperature occurs over a large part of the South Atlantic and certain parts of the Pacific, but at the bottom of the North Atlantic basin and over a very large portion of the Pacific the temperature is higher than 35° F. In depths beyond 2,000 fathoms the average temperature over the floor of the North Atlantic is about 2° F. above the average temperature at the bottom of the Indian Ocean and South Atlantic, while the average temperature of the bed of the Pacific is intermediate between these.

It is admitted that the low temperature of the deep sea has been acquired at the surface in Polar and sub-Polar regions, chiefly within the higher latitudes of the southern hemisphere, where the cooled surface water sinks to the bottom and spreads slowly over the floor of the ocean into equatorial regions. These cold waters carry with them into the deep sea the gases of the atmosphere which are everywhere taken up at the surface according to the known laws of gas absorption. In this way myriads of living animals are enabled to carry on their existence at all depths in the open ocean. The nitrogen remains more or less constant at all times and places, but the proportion of oxygen is frequently much reduced in deep water, owing to the processes of oxidation and respiration which are there going on.

The deep sea is a region of darkness as well as of low temperature, for the direct rays of the sun are wholly absorbed in passing through the superficial layers of water. Plant-life is in consequence quite absent over 93 per cent. of the bottom of the ocean, or 66 per cent. of the whole surface of the lithosphere. The abundant deep-sea fauna, which covers the floor of the ocean, is, therefore, ultimately dependent for food upon organic matter assimilated by plants near its surface, in the shallower waters near the coast lines, and on the surface of the dry land itself.

As has been already stated, about 7,000,000 square geographical miles of the sea floor lies within the 100-fathom line, and

this area is in consequence subject to seasonal variations of temperature, to strong currents, to the effects of sunlight and presents a great variety of physical conditions. The planktonic plant life is here reinforced by the littoral seaweeds and animal life is very abundant. About 40 per cent. of the water over the bottom of this shallow water area has a mean temperature under 40° F., while 20 per cent. has a mean temperature between 40° and 60° F., and 40 per cent. a temperature of over 60° F.

It follows from this that only 3 per cent. of the floor of the ocean presents conditions of temperature favorable for the vigorous growth of corals and those other benthonic organisms which make up coral reefs and require a temperature of over 60° F. all year round. On the other hand, more than half of the surface of the ocean has a temperature which never falls below 60° F. at any time of the year. In these surface waters, with a high temperature, the shells of pelagic Molluscs, Foraminifera, Algæ, and other planktonic organisms are secreted in great abundance and fall to the bottom after death.

It thus happens that, at the present time, over nearly the whole floor of the ocean we have mingled in the deposits the remains of organisms which had lived under widely different physical conditions, since the remains of organisms which lived in tropical sunlight, and in water at a temperature above 80° F., all their lives, now lie buried on the same deposit on the sea-floor, together with the remains of other organisms which lived all their lives in darkness and at a temperature near to the freezing-point of fresh water.

Marine Deposits on the Ocean-floor.

The marine deposits now forming over the floor of the ocean present many interesting peculiarities according to their geographical and bathymetrical position. On the continental shelf, within the 100-fathom line, sands and gravel predominate, while on the continental slopes beyond the 100-fathom line, Blue Muds, Green Muds and Red Muds, together with Volcanic Muds and Coral Muds, prevail, the two latter kinds of deposits being, however, more characteristic of the shallow water around oceanic islands. The composition of all these Terrigenous Deposits depend on the structure of the adjoining land. Around continental shores, except where coral reefs, limestones and volcanic rocks are present, the material consists principally of fragments and minerals derived from the disintegration of the ancient rocks of the continents, the most characteristic and abundant mineral species being quartz. River detritus extends in many instances far from the land, while off high and bold coasts, where no large rivers enter the sea, pelagic conditions may be found in somewhat closer proximity to the shore line. It is in these latter positions that Green Muds containing much glauconite, and other deposits containing many phosphatic nodules, have for the most part been found; as, for instance, off the eastern coast of the United States, off the Cape of Good Hope, and off the eastern coasts of Australia and Japan. The presence of glauconitic grains and phosphatic nodules in the deposit at these places appears to be very intimately associated with a great annual range of temperature in the surface and shallow waters, and the consequent destruction of myriads of marine animals. As an example of this phenomenon may be mentioned the destruction of the tile-fish in the spring of 1882 off the eastern coast of North America, when a layer six feet in thickness of dead fish and other marine animals was believed to cover the ocean-floor for many square miles.

In all the Terrigenous Deposits the evidences of the mechanical action of tides, of currents, and of a great variety of physical

conditions, may almost everywhere be detected, and it is possible to recognize in these deposits an accumulation of materials analogous to many of the marine stratified rocks of the continents, such as sandstones, quartzites, shales, marls, greensands, chalks, limestones, conglomerates and volcanic grits.

With increasing depth and distance from the continents the deposits gradually lose their terrigenous character, the particles derived directly from the emerged land decrease in size and in number, the evidences of mechanical action disappear, and the deposits pass slowly into what have been called Pelagic Deposits at an average distance of about 200 miles from continental coast-lines. The materials composing Pelagic Deposits are not directly derived from the disintegration of the continents and other land-surfaces. They are largely made up of the shells and skeletons of marine organisms secreted in the surface waters of the ocean, consisting either of carbonate of lime, such as pelagic Molluscs, pelagic Foraminifera, and pelagic Algæ, or of silica, such as Diatoms and Radiolarians. The inorganic constituents of the Pelagic Deposits are for the most part derived from the attrition of floating pumice, from the disintegration of water-logged pumice, from showers of volcanic ashes and from the *débris* ejected from submarine volcanoes, together with the products of their decomposition. Quartz particles which play so important a *rôle* in the Terrigenous Deposits, are almost wholly absent, except where the surface waters of the ocean are affected by floating ice, or where the prevailing winds have driven the desert sands far into the oceanic areas. Glauconite is likewise absent from these abysmal regions. The various kinds of Pelagic Deposits are named according to their characteristic constituents, Pteropod Oozes, Globigerina Oozes, Diatom Oozes, Radiolarian Oozes and Red Clay.

The distribution of the deep-sea deposits over the floor of the ocean is shown on the map here exhibited, but it must be remembered that there is no sharp line of demarcation between them; the Terrigenous pass gradually into the Pelagic Deposits, and the varieties of each of these great divisions also pass insensibly the one into the other, so that it is often difficult to fix the name of a given sample.

On another map here exhibited the percentage distribution of carbonate of lime in the deposits over the floor of the ocean has been represented, the results being founded on an extremely large number of analyses. The results are also shown in the following table:

	Sq. Geog. Miles.	Percentage.
Over 75% $CaCO_3$.....	6,000,000	5·8
50 to 75% "	24,000,000	23·2
25 to 50% "	14,000,000	13·5
Under 25% "	59,000,000	57·5
	103,000,000	100

The carbonate of lime shells derived from the surface play a great and puzzling *rôle* in all deep-sea deposits, varying in abundance according to the depth of the ocean and the temperature of the surface waters. In tropical regions removed from land, where the depths are less than 600 fathoms, the carbonate of lime due to the remains of these organisms from the surface may rise to 80 or 90 per cent.; with increase of depth, and under the same surface conditions, the percentage of carbonate of lime slowly diminishes, till, at depths of about 2,000 fathoms, the average percentage falls to about 60, at 2,400 fathoms to about 30, and at about 2,600 fathoms to about 10, beyond which depth there may be only traces of carbonate of lime due to the presence of surface shells. The thin and more delicate surface shells first disappear from the deposits; the thicker and denser ones alone persist to greater depths. A careful examination of a large number of observations

shows that the percentage of carbonate of lime in the deposits falls off much more rapidly at depths between 2,200 and 2,500 fathoms than at other depths.

The Red Clay which occurs in all the deeper stretches of the ocean far from land, and covers nearly half of the whole sea-floor, contains—in addition to volcanic *débris*, clayey matter, the oxides of iron and manganese—numerous remains of whales, sharks, and other fishes, together with zeolytic crystals, manganese nodules, and minute magnetic spherules, which are believed to have a cosmic origin. One haul of a small trawl in the Central Pacific brought to the surface on one occasion, from a depth of about two and a half miles, many bushels of manganese nodules, along with fifteen hundred sharks' teeth, over fifty fragments of earbones and other bones of whales. Some of these organic remains, such as the *Carcharodon* and *Lamna* teeth and the bones of the Ziphioid whales, belong apparently to extinct species. One or two of these sharks' teeth, earbones or cosmic spherules, may be occasionally found in a Globigerina Ooze, but their occurrence in this or any deposits other than Red Clay is extremely rare.

Our knowledge of the marine deposits is limited to the superficial layers; as a rule the sounding tube does not penetrate more than six or eight inches, but in some positions the sounding-tube and dredge have been known to sink fully two feet into the deposit. Sometimes a red clay is overlaid by a Globigerina Ooze, more frequently a Red Clay overlies a Globigerina Ooze, the transition between the two layers being either abrupt or gradual. In some positions it is possible to account for these layers by referring them to changes in the condition of the surface waters; but in other situations it seems necessary to call in elevations and subsidences of the sea-floor.

If the whole of the carbonate of lime shells be removed by dilute acid from a typical sample of Globigerina Ooze, the inorganic residue left behind is quite similar in composition to a typical Red Clay. This suggests that possibly, owing to some hypogene action, such as the escape of carbonic acid through the sea-floor, a deposit that once was a Globigerina Ooze might be slowly converted into a Red Clay. However, this is not the interpretation which commends itself after an examination of all the data at present available; a consideration of the rate of accumulation probably affords a more correct interpretation. It appears certain that the Terrigenous Deposits accumulate much more rapidly than the Pelagic Deposits. Among the Pelagic Deposits the Pterapod and Globigerina Oozes of the tropical regions, being made up of the calcareous shells of a much larger number of tropical species, apparently accumulate at a greater rate than the Globigerina Oozes in extra-tropical areas. Diatom Ooze being composed of both calcareous and siliceous organisms has again a more rapid rate of deposition than Radiolarian Ooze. In Red Clay the minimum rate of accumulation takes place. The number of sharks' teeth, of earbones and other bones of Cetaceans, and of cosmic spherules in a deposit may indeed be taken as a measure of the rate of deposition. These spherules, teeth and bones are probably more abundant in the Red Clays, because few other substances there fall to the bottom to cover them up, and they thus form an appreciable part of the whole deposit. The volcanic materials in a Red Clay having, because of the slow accumulation, been for a long time exposed to the action of the sea-water, have been profoundly altered. The massive manganese-iron nodules and zeolitic crystals present in the deposit are secondary products arising from the decomposition of these volcanic materials, just as the formation of glauconite, phosphatic, and calcareous and barytic nodules accompanies the decompo-

sition of terrigenous rocks and minerals in deposits nearer continental shores. There is thus a striking difference between the average chemical and mineralogical composition of Terrigenous and Pelagic Deposits.

It would be extremely interesting to have a detailed examination of one of those deep holes where a typical Red Clay is present, and even to bore some depth into such a deposit if possible, for in these positions it is probable that not more than a few feet of deposit have accumulated since the close of the Tertiary period. One such area lies to the south-west of Australia, and its examination might possibly form part of the program of the approaching antarctic explorations.

Life on the Ocean-floor.

It has already been stated that plant-life is limited to the shallow waters, but fishes and members of all the invertebrate groups are distributed over the floor of the ocean at all depths. The majority of these deep-sea animals live by eating the mud, clay, or ooze, or by catching the minute particles of organic matter which fall from the surface. It is probably not far from the truth to say that three-fourths of the deposits now covering the floor of the ocean have passed through the alimentary canals of marine animals. These mud-eating species, many of which are of gigantic size when compared with their allies living in the shallow coastal waters, become in turn the prey of numerous rapacious animals armed with peculiar prehensile and tactile organs. Some fishes are blind, while others have very large eyes. Phosphorescent light plays a most important *rôle* in the deep sea, and is correlated with the prevailing red and brown colors of deep-sea organisms. Phosphorescent organs appear sometimes to act as a bull's-eye lantern to enable particles of food to be picked up, and at other times as a lure or a warning. All these peculiar adaptations indicate that the struggle for life may not be much less severe in the deep sea than in the shallower waters of the ocean.

Many deep-sea animals present archaic characters; still the deep sea cannot be said to contain more remnants of faunas which flourished in remote geological periods than the shallow and fresh waters of the continents. Indeed, king-crabs, Lingulas, Trigonias, Port Jackson sharks, *Ceratodus*, *Lepidosiren* and *Protopterus* probably represent older faunas than anything to be found in the deep sea.

Sir Wyville Thompson was of the opinion that, from the Silurian period to the present day, there had been as now a continuous deep ocean with a bottom temperature oscillating about the freezing-point of fresh water, and that there had always been an abyssal fauna. I incline to the view that in Paleozoic times the ocean-basins were not so deep as they are now; that the ocean then had throughout a nearly uniform high temperature, and that life was either absent or represented only by bacteria and other low forms in great depths, as is now the case in the Black Sea, where life is practically absent beyond 100 fathoms, and where the deeper waters are saturated with sulphuretted hydrogen. This is not, however, the place to enter on speculations concerning the origin of the deep-sea fauna, nor to dwell on what has been called 'bipolarity' in the distribution of marine organisms.

JOHN MURRAY.

(*To be Continued.*)

THE EARLY PRESIDENTS OF THE AMERICAN ASSOCIATION.

IV.

LOVERING.*

Lovering† was born in Charlestown, Massachusetts, now a portion of Boston, in

* A portrait of Joseph Lovering is printed as frontispiece.

† See sketch in *Popular Science Monthly*, with an engraved portrait on wood, Vol. XXXV., p. 690, September, 1889. Also see article in *Scientific American*, February 27, 1892, with a half-tone portrait.

1813, and inherited a fondness for mathematics from his father who was a surveyor by profession. He was fitted for college by the Rev. James Walker, and entered Harvard in the Sophomore year in the class of 1833, a class that included several members who were afterwards called to fill chairs in their *alma mater*, and one—Jeffries Wyman—who became a president of our Association. Lovering stood fourth in his class and he delivered the salutatory oration at the commencement exercises.

For a year after leaving Harvard he taught in Charlestown, but an inclination towards theology led him to enter the Harvard Divinity School, also at the same time devoting some attention to mathematical studies. It was probably that fact that led to his appointment as tutor in mathematics and physics in 1836 to fill the place made vacant by the illness of Professor John Farrar, and thus his long connection with Harvard began which only terminated in his death, fifty-six years later.

In 1838 Professor Farrar retired from active duty and Lovering was made his successor in the Hollis chair of mathematics and natural philosophy, which he then held for exactly fifty years, when he in his turn retired and was made *emeritus*. He was the first member of the Harvard faculty to fill a professorship for half a century, and his length of academic service was only exceeded by that of Henry Flynt, who was a tutor in Harvard, early in its history. Lovering was also director of the Jefferson Physical Laboratory, holding that office during 1884–88, and he was a regent of Harvard during 1853–54 and again during 1857–70.

In the development of the Harvard astronomical observatory he took a prominent part. He was associated with Professor William C. Bond in 1840, when with but few instruments and indifferent facilities, the beginning of the work in astronomy was made in the Davis House in Cambridge. It is from this small beginning that the present splendid observatory has grown. When Alexander von Humboldt induced the Royal Society of London to undertake the procuring of simultaneous observations on terrestrial magnetism in Great Britain and the colonies, the coöperation of the United States was sought, and one of the three stations in America was located in Cambridge where the taking of the observations was under the direction of Bond and Lovering. Several undergraduates of Harvard aided in the work, and among them was Benjamin A. Gould, who served the American Association as president in 1868.

The exacting duties of his work at Harvard and his own active interest in our Association left him but little time for scientific investigations. Still from 1867 till 1876 he had charge of the computations for determining transatlantic longitudes from telegraphic observations on cable lines, and under the direction of the U. S. Coast Survey, of which his colleague Benjamin Peirce was then superintendent, and the results of his work were given in volumes II. and IX. of the memoirs of the American Academy of Arts and Sciences. It was also to this source that he contributed in 1873 his great memoir on the aurora borealis. His shorter papers were more than one hundred in number and many of them appeared in our Proceedings. They testify to his unceasing activity as well as to his unusual ability. Mention should be made also of the fact that he was associated with Benjamin Peirce in the publication of the Cambridge Miscellany of Mathematics and Physics, to which he contributed articles on The Internal Equilibrium of Bodies; The Application of Mathematical Analysis to Physical Research; The Divisability of Matter, and similar subjects which attracted wide attention throughout this country and the scientific world.

It would be pleasant to review at length his work in connection with the American Association, but the memory of fifteen successful meetings and an equal number of volumes of Proceedings edited by him are all that need be mentioned. His interest in the American Academy of Arts and Sciences was also noteworthy. He was its secretary during 1869–73; its vice-president during 1874–80, and its president during 1881–88.

And so it was with the American Association, the magnificent pioneer work by Lovering made possible the wonderful successes by Putnam, during whose administration our Association reached its high tide of membership and attendance. We shall do well to place the name of Lovering high among those of the fathers of the Association.

The successful meeting in Portland was followed by the even more successful meeting at Hartford, Connecticut, which, according to the permanent secretary, "was one that will make a special era in the history of the Association."* In attendance it was one of the three largest meetings held, subsequent to their resumption in 1866. The presiding officer of the meeting was John Lawrence Le Conte, of Philadelphia.

LE CONTE.

This distinguished entomologist† was born in New York City in 1825. He was of Huguenot ancestry, as is suggested by his name. The first of the family to come to this country was Guillaume Le Conte, who settled in New Rochelle early in the eighteenth century. Among his descendants were Lewis and John Eatton Le Conte, both of whom achieved some prominence for their interest in science. The latter, Major John Eatton Le Conte, entered the U. S. Topographical Engineers and was distinguished as a botanist and as an entomologist. His son is the subject of this sketch.

After finishing his collegiate education at Mount St. Mary's College, in Emmettsburg, Maryland, Le Conte entered the College of Physicians and Surgeons in New York City and was graduated there in 1846. Possessed of independent means, he never took up the actual practice of medicine, but yielded to a fondness for natural history, inherited from his father, he devoted himself to travel, visiting many portions of the United States during the years between 1841 and 1851.

Says Scudder:

> The subject of the faunal relations of animals was a favorite one with Le Conte. He returned to it again and again; he was the first to district much of the vast and then almost unexplored regions west of our prairie country.*

While still a student of medicine he published his first scientific paper, which contained descriptions of more than twenty species of Caribidæ from the eastern United States. His preference for entomology continued throughout his life, and how industrious he was in that direction and what an influence he exerted on that branch of science, is shown by the statement that more than sixty monographic essays, some of them expanding to the form of a volume, and all of them after the first five years of work, direct and valuable contributions to the taxonomy of the order (Coleoptera) appeared from his pen.†

The sketch by Scudder, from which so

* Proceedings, American Association for the Advancement of Science, Vol. XXIII., p. 150.

† Biographical Memoirs of the National Academy of Sciences, Vol. XI., p. 216. John Lawrence Le Conte, by Samuel H. Scudder. This article, accompanied by a photo-gelatine portrait, appeared in the *Transactions of the American Entomological Society* for August, 1884. The *Popular Science Monthly*, Vol. V., p. 620, September, 1874, contains a sketch with engraved portrait on wood.

* Biographical Memoirs, p. 272.

† Samuel H. Scudder, in Biographical Memoirs, p. 274.

much of this material has been taken, contains the following appreciation of Le Conte's work:

That Le Conte was the greatest entomologist this country has yet produced is unquestionable. *Facile princips* will be the universal judgment both now and by posterity.*

Mention must be made of the fact that when the civil war broke out he entered the Union army as surgeon of volunteers and was afterward advanced to the office of medical inspector, with the rank of lieutenant colonel, which he retained until the end of the war. In this duty his fine organizing power and good sense showed themselves to excellent advantage. From 1878 till his death in 1883, he again served the government as chief clerk of the U. S. Mint in Philadelphia.

One of our past presidents, Lesley, who was his life-long friend, said of him:

Let the world reverence his memory as a discoverer, as a philosopher, as a genius.

HILGARD.

For the meeting held in Detroit in 1875 Julius Erasmus Hilgard, of the U. S. Coast Survey, was chosen to preside, and thus for a third time in our history an officer of the U. S. Coast Survey was honored by an election to the highest office within the gift of our Association. Hilgard† was the eldest son of a distinguished Bavarian jurist and writer and came with his father to this country in 1835. Although at that time only ten years of age, he had completed the third grade of the gymnasium in his native town of Zweibrucken, and his subsequent education was for the most part obtained from his father or self-acquired.

In 1843 he went to Philadelphia with a view to the study of engineering and practical employment. He was soon actively at work on one of the new railway lines then coming into existence. While so engaged he became acquainted with Alexander D. Bache, and in 1845 when Bache became superintendent of the Coast Survey, he offered young Hilgard a subordinate appointment in this service, which was promptly accepted with the statement that he preferred to "do high work at low pay than low work at high pay."*

In the short time of fifteen years he rose from the lowest place in the survey to that of first assistant, which was second only to the office of superintendent. During the greater part of the civil war and until the death of Bache in 1867, the actual duties of the superintendent devolved on him. Peirce, who succeeded Bache said of this service:

The distinguished ability with which this difficult service was discharged was manifest to all. He (Hilgard) has extended to me the benefit of this experience liberally and loyally. While I willingly acknowledge myself under deep and lasting obligations to him for the aid thus rendered me, I can also testify that in all respects he has been equally true to my predecessor, the greatness of whose reputation has not been diminished in his keeping.

Hilgard continued as assistant in charge of the office during the superintendency of Peirce, and his successor, Patterson, but in 1881 his services received their just reward by his appointment as superintendent of the Coast Survey, which place he then held for four years. On the advent of a new administration, after a faithful service of forty years, he was obliged to resign. It is not pertinent to this address to discuss the reasons that led to his resignation, but

There can be no two opinions upon the character and value of his life-work in connection with the Coast Survey. He brought into

*Samuel H. Scudder, in Biographical Memoirs, p. 280.

† Biographical Memoirs of the National Academy Vol. III., p. 327. Julius E. Hilgard, by Eugene W. Hilgard. See also sketch with engraved portrait on wood in *Popular Science Monthly*, Vol. VII., p. 617, September, 1875, and Appleton's Annual Cyclopædia for 1891, p. 628, with portrait.

*Biographical Memoirs, p. 330.

that branch of the public service a rare combination of culture, zeal, knowledge of the world, and executive ability; and no man living will claim to have done more than he did for the character and efficiency of the survey.*

The arduous and confining duties of his office in the Coast Survey naturally limited his scientific work to the sphere embraced by his practical work, but he was also recognized "as an active student in other branches of science, especially dynamics and molecular physics."† Of such work, the most important, however, was that connected with the magnetic survey of the United States, which was carried on at the expense of the Bache fund, the direction of which was entrusted to Hilgard by the National Academy of Sciences.

His lectures on The Tides and Tidal Action in Harbors, delivered before the American Institute in New York, was regarded as remarkable for its lucid and terse exposition of principles without the aid of mathematical symbols. Later he delivered a course of twenty lectures before the students of the Johns Hopkins University on the subject of Extended Territorial Surveying, which was received with much appreciation.

His life-work, however, was in connection with the Coast Survey, and his relation to it will always be accepted as his greatest contribution to American science. From 1886 till his death, in 1891, he lived quietly in retirement, vainly endeavoring to regain the health and strength which he had sacrificed in the patriotic performance of his duty to the country of his adoption.

ROGERS.

It was indeed a happy suggestion that led our Association in 1881 to recognize the life-long interest of William Barton Rogers in its welfare by electing him as the first of our honorary fellows. Rogers was the last presiding officer of the Association of American Geologists and Naturalists, and it was he who inducted to office William C Redfield, at the first meeting of the American Association in 1848. It is for this reason that his name stands first in the list of our presidents. This name also appears as the twenty-fifth on the list, for in 1875 he was honored by an election to the presidency and he presided over the meeting held in Buffalo in 1876.

It is not an easy matter to find a suitable designation for so versatile and accomplished a scientist as Rogers, for he was master of more subjects than one, and belonged to a period in the history of science, when teachers were students and authorities in several branches of learning. He was one of the four sons of Patrick K. Rogers, who, for a decade, was professor of natural philosophy and mathematics at William and Mary College, Virginia. William Barton* was born in Philadelphia in 1804, and followed his parents to Williamsburg, in 1819. His early education was received from his father, and for a time he was a student of William and Mary. Later he became an assistant to his father, who wrote:

My second son, who is now in his twentieth

* SCIENCE, May 15, 1891.

† *Popular Science Monthly*, Vol. VII., p. 618.

* There are many sketches of W. B. Rogers, among which are a notice of William Barton Rogers, founder of the Massachusetts Institute of Technology, by Josiah P. Cooke, in *Proceedings of the American Academy of Arts and Sciences*, Vol. XVIII., p. 426; Memoirs of William Barton Rogers, 1804–1882, presented before the National Academy, by Francis A. Walker; The Brothers Rogers read before the American Philosophical Society, by Dr. William S. W. Ruschenberger; and a memorial pamphlet issued by the Massachusetts Institute of Technology with a photo-gelatine portrait. There is also a sketch in the *Popular Science Monthly*, Vol. IX., p. 606, September, 1876, with an engraved portrait on wood, where monthly there has been published a life and letters of William Barton Rogers edited by his wife, Emma Savage Rogers, in two volumes, Boston, 1896, that contains several portraits both of himself and of his brothers.

year, and has a very extraordinary passion for physico-mathematical sciences.*

In the autumn of 1825, with his younger brother, Henry, he went to Baltimore, and there, for a time, pursued various vocations including that of scientific advisor to Isaac Tyson, the chemical manufacturer, but chiefly that of teacher in a school established by the two young men in Windsor. The pursuit of science was the aim of his ambition, and he was fortunate in securing an appointment, early in 1827, to deliver a course of lectures before the Maryland Institute. These were so successful that he gave a second course a year later. Concerning these Henry wrote to his father:

William is still able to command large and ever increasing classes. * * * I cannot refrain from expressing my surprise at William's great success, aided as he is by little more than the blackboard and chalk.†

Walker said of these lectures that he then:

First displayed upon an adequate field, that power of clear exposition felicitous illustration which he possessed in a degree, perhaps, never excelled.‡

In August, 1828, came the death of the elder Rogers, and two months later William was chosen his father's successor in the chair of natural philosophy and chemistry in William and Mary College, "and thence forward became, in a large measure, the head of the family."§ For some years he continued in the active possession of that chair, also during part of the time temporarily filling the chair of mathematics. His professorial duties were naturally paramount, but it must be noted that at that time he published a paper on Dew, and with his brother Henry one on the Voltaic Battery, both of which were subjects directly connected with his professorship.

* Life and Letters, p. 26.
† Idem, p. 47.
‡ Biographical Memoirs, p. 3.
§ Life and Letters, p. 54.

Of subjects less directly associated with his college duties, to which he devoted much attention, were topics connected with geology. He wrote a series of articles on the Green Lands and Marls of Eastern Virginia, describing their value as fertilizers, and says Cooke:

Next we find the young professor going before the legislature of Virginia, and, while modestly presenting his own discoveries, making them the occasion for urging upon that body the importance of a systematic geological survey for developing the resources of the State.

The year 1835 saw the culmination of his ambition in that respect, for in March he was appointed director of the Geological Survey of Virginia.

As was anticipated, says Cooke:

The survey led to a large accumulation of material, and to numerous discoveries of great local importance. As this was one of the earliest geological surveys undertaken in the United States, its directors had, in great measure, to devise the methods and lay out the plans of investigation which have since become general. * * * [Also] there are four or five general results of Professor Roger's geological work at this period, which have exerted a permanent influence in geological science.*

These general results included the study of the solvent action of water in various minerals and rocks; the demonstration that coal beds stand in close genetic relation to the amount of disturbance to which the inclosing strata have been submitted; the announcement and discussion of the wave theory of mountain chains; and the law of distribution of faults. In working out these subjects and in the presentation of papers discussing them he was associated largely with his brother Henry, who was at that time State Geologist of Pennsylvania. It has been well said that "together they unfolded the historical geology of the great Appalachian chain."

* Notice of William Barton Rogers, p. 429.

Popular interest in the survey gradually dwindled, and in the legislature decided opposition manifested itself, until in 1841, its political enemies succeeded in preventing the passing of an appropriation and so the survey came to an end.

It was also in the year 1835 that Rogers was chosen to the chair of natural philosophy and geology in the University of Virginia. Of his career, then President William L. Brown, of the Agricultural and Mechanical College of Alabama is quoted as saying:

> I have seen his lecture hall so crowded with young men, eager to hear his eloquent presentation of the subject by the professor, whom they so greatly admired, that not even standing room could be found in the hall. All the aisles would be filled, and even the windows crowded from the outside with eager listeners. His manner of presenting the commonest subject in science—clothing his thoughts, as he always did, with a marvelous fluency and clearness of expression and beauty of diction unsurpassed—caused the warmest admiration, and often aroused the excitable nature of Southern spirit to the exhibition of enthusiastic demonstrations of approbation.

He resigned his chair in 1853 in order to devote more of his time to original investigation, but the students never forgot him, and at the celebration of the semi-centennial of the University of Virginia in 1875, he received a perfect ovation. In the language of a contemporary Virginia newspaper:

> The old students beheld him the same William B. Rogers who thirty-five years before had held them spellbound in his class of natural philosophy; and as the great orator warmed up, then men forgot their age; they were again young; and showed their enthusiasm as wildly as when in days of yore enraptured by his eloquence, they made the lecture room of the university ring with their applause.*

Ever since boyhood it had been his cherished hope to work some day side by side with his brother Henry. Such an opportunity now presented itself. The younger man had settled in Boston some years previous, and released from the duties of his collegiate work, William B. Rogers, gladly sought the congenial atmosphere of the northern city where it was possible to devote himself to original work. He associated himself with the American Academy of Arts and Sciences and the Boston Society of Natural History, taking an active part in the proceedings of both of these learned societies, in the latter of which he was in close communication with Agassiz, Wyman, and Jackson. At first during this period his papers dealt with matters of geology and paleontology but later he took up work in physics. No discussion of these publications is here possible, but that they were of high character is conceded. Concerning a paper discussing the phenomena of smoke rings and rotating rings in liquids which was published in 1858, Cooke said: "In this paper Professor Rogers anticipated some of the later results of Helmholtz and Sir William Thompson."*

The crowning and greatest work of Professor Rogers' life was the founding of the Massachusetts Institute of Technology. That achievement was so important in its results, so far-reaching in its prospects, and so complete in its details, that it overshadows all else.

> In 1859 [says Walker], Professor Rogers, gathering around him a number of the first citizens of Boston, begun the public discussion of a scheme for technical education, to be associated on one side, with research and original investigation upon the largest scale, and on the other, with agencies for the popular diffusion of useful knowledge. So entirely unfamiliar to the public mind of the day was the idea of technological instruction, beyond the simplest requirements of civil engineering, that the Legislature of Massachusetts could not be brought to see the full merits of Professor Rogers' most comprehensive and as all now view it thor-

* Life and Letters, Vol. II., p. 325.

* Cooke's Notice of Rogers, p. 433.

oughly practical plan, but enough was done by the Legislature during the few years following to secure the chartering, in 1862 and the inauguration in 1865 of the Massachusetts Institute of Technology of which Professor Rogers became the first president, devoting to it all the energy and enthusiasm of his impulsive nature and all the varied wealth of his accomplishments and acquirements. For the rest of his life this was chosen work.*

Rogers lived to transfer to a worthy successor the completed edifice—well established and equipped—an enduring monument to the nobility of character and the consecration of talents. Honored and loved by his associates and students, he came to be recognized as "founder and father perpetual, by a patent indefeasible." †

Of all the delightful memories of the Boston meeting in 1880 the meeting with Rogers is my pleasantest recollection. He was the central figure, losing no opportunity to make that meeting the greatest one in the history of our association. Never shall I forget when he rose

> Tall in stature, with a figure of the type known to us through the pictures of Henry Clay; with a face destitute of all assumption or arrogance, was singularly commanding; with a voice whose compass and quality were capable of producing at once the largest and the finest effects of speech. ‡

and bade the Association welcome. He said:

> I thank my friends for the patience with which they have listened to one who does not like to call himself an old man, but who feels something of the spirit of the war-worn soldier, who likes at times to shoulder his crutch and fight his battles over again. §

Two years later, at the same place, he rose to address the graduating class of the Institute.

> His voice was at first weak and faltering but, as was his wont, he gathered inspiration from his theme, and for the moment his voice rang out in its full volume and in those well-remembered, most thrilling tones; then, of a sudden, there was silence in the midst of speech; that stately figure suddenly drooped; the fire died out of that eye, ever so quick to kindle at noble thoughts, and, before one of his attentive listeners had time to suspect the cause, he fell to the platform—instantly dead. All his life he had borne himself most faithfully and heroically, and he died as so good a knight would surely have wished, in harness, at his post; and in the very part and act of public duty.*

At the Buffalo meeting, in 1876, Simon Newcomb, 'one of the most celebrated astronomers of our time,' was chosen to preside over the Nashville meeting. Newcomb still lives and is our senior past president. He marks the dividing line between our earlier and later presidents. †

Marcus Benjamin.
U. S. National Museum.

* Biographical Memoirs, p. 11.
† Cooke's Notice of Rogers, p. 427.
‡ Biographical Memoirs, by Walker, p. 5.
§ Proceedings, American Association for the Advancement of Science, Vol. XXIX., 1880, p. 739.

THE SENSE OF HEARING IN ANTS.

For many years it has been the generally accepted opinion of naturalists that ants do not possess a sense of hearing, at least within the range of sounds perceptible to the human ear. This opinion has been based upon the failure of the experiments along this line to show any effect whatever of the loudest and shrillest noises upon the ants with which they have been tried. Foremost among the scientists who have investigated this subject may be mentioned Lubbock, Huber and Forel, whose results have all been negative.

I am not prepared to explain why the results heretofore obtained have been so decidedly negative, while those described in this article are so decidedly affirmative, unless it may be that these particular species have never been experimented upon

* Biographical Memoirs, by Walker, p. 13.
† Nature, Vol. LX., p. 1, May 4, 1899.

before. The results of these experiments can merely be stated, and the conclusions to be drawn from them left to the mind of the reader.

Only four species of ants were concerned in the experiments: *Lasius americanus* and *Formica nitidiventris*, both belonging to the family FORMICIDÆ, and *Cremastogaster lineolata* and a species of the genus *Aphænogaster*, belonging to the MYRMICIDÆ. From the affirmative results obtained from these four species, even if they were absolutely certain, we could not, of course, draw any certain affirmative conclusions as to the whole group of ants; but even these few results are at least a favorable indication.

The experiments were performed both upon individuals and upon whole colonies. As there were about eighty experiments recorded for the four species, I can describe only a few of them and make general statements as to the others. The following are extracts from my notebook, and are significant in themselves.

Cremastogaster lineolata.

(1) May 2, 1899, 10:45 a. m. Ant wandering about isolated. I struck a steel sounding-bar of vibration-number 4096 (complete vibrations). Ant immediately raised its head and waved the antennæ.

(2) 10:56. Ant moving left front leg. Blew several blasts on a small bottle, being very careful not to blow upon the ant. Ant drew back the antennæ and began waving them immediately.

(3) 11:00. Same conditions. Struck the sounding-bar as in (1). Ant turned head and antennæ *toward the bar*, waving the antennæ slightly.

Another individual, same species.

(4) May 2, 5:05 p. m. Ant perfectly quiet. Blew short blasts on a small bottle, as in (2). Ant raised its head and waved the antennæ.

(5) 5:09. Same conditions. Blew a long, steady blast on a shrill wooden whistle. Ant began waving antennæ violently and kicking with one leg.

(6) 5:25. Ant walking along slowly on a strip of paper. Blew a shrill blast on a tin whistle. Ant started forward suddenly and walked faster.

(7) 5:29. Ant quiet. Blew a long blast on the shrill wooden whistle. Ant turned nearly half way around *toward the whistle*, waving the antennæ.

(8) 5:31. Ant quiet. Blew a short blast on the wooden whistle. Ant raised the antennæ high in the air and moved the abdomen up and down several times.

(9) 5:32. Ant quiet, facing me. Same experiment. Ant started *backward* suddenly and then began waving the antennæ.

Another individual, same species.

(10) May 4, 10:18 a. m. Ant quiet. Struck a tuning-fork (key middle A) and touched it several times to a piece of cardboard suspended in the air about two inches above the ant, making clear sounds. Ant raised the antennæ slightly at each sound.

Lasius americanus.

(11) May 8, 11:08 a. m. Ant walking along on a piece of paper. Touched a tuning-fork, as in (10), to a card a little in front of the ant. Ant immediately turned around and walked *in the opposite direction*.

Another individual, same species.

(12) May 11, 10:48 a. m. Ant wandering about isolated. Touched a card several times to a rapidly rotating milled disk near the ant, producing loud sounds. Ant walked more slowly, apparently crouching down, but occasionally starting forward as the sounds became more piercing.

Aphænogaster sp.

(13) May 19, 3:18 p. m. Ant perfectly quiet, confined by loose cotton in a test-tube. Suspended the tube in the air near the steel sounding-bar mentioned in (1) and struck the bar several times. Ant first

moved the antennæ, then the head, then the thorax, to and fro, and finally began to walk.

Formica nitidiventris.

(14) May 19, 4:08 p. m. Ant quiet, and confined in a test-tube as described in (13). Suspended the tube in the air near the rotating milled disk (12). At each sound from this apparatus the ant showed unmistakable signs of agitation, quickly moving the head and antennæ.

In addition to these, I may also mention an experiment tried on the colony as a whole with each of these species except *Formica nitidiventris*, with which I had no opportunity to try it. The colony being quiet in their nest under a plate of glass, I produced with the lips or with an instrument clear, shrill notes, taking the greatest care not to blow upon the nest or to allow anything else but the sound to disturb the colony. The ants instantly showed, by their quick movements in all directions, unmistakable signs of excitement or alarm. I tried this over and over again with each of the three species, in the presence of visitors to the laboratory, and the result was invariably the same. All who saw it admitted at once that their doubts as to the sense of hearing in those ants were entirely removed.

As to the remainder of the experiments, lack of space prevents me from describing them, but let it suffice to say that by far the greater part of them gave results just such as those already described.

The persistence of these affirmative results led me to a conclusion which is embodied in the statement of the following thesis: *The ants, or at least some of the ants, are capable of perceiving vibrations, conducted through the air or other media, which are audible as sound to the human ear.* It will be noticed that I do not assert that any of the ants *hear*, in the ordinary sense of the word; neither do I deny it; my statement is merely that some of them are capable of *perceiving* ordinary sound vibrations, which does not necessarily imply a true sense of hearing. However, in all the experiments, great care was taken in various ways to prevent the vibrations from reaching the ants through solids as media. And if it be true that this sensation, apparently due to a sense of hearing, is merely that of a mechanical vibration or jarring produced by the sound waves (and hence would pertain in a measure to the sense of touch), how shall we explain the results of experiments like (3), (7), (9) and (11), which certainly indicate a sense of direction? And how shall we account for the fact, shown in many of my experiments, that some ants which pay little attention to being knocked and jarred about in their glass prisons are driven nearly frantic, apparently, by shrill sounds? The result of experiment (8) should also be noted as of special importance. For this ant (*Cremastogaster lineolata*) is a stridulating species, and the movement of the abdomen mentioned is one of stridulation, producing a minute sound; the significance of this fact is obvious, indicating a response on the part of the ant to the sound of the whistle.

I might proceed to discuss at length the results of these experiments, arguing from standpoints based on the principles of psychology; but for the present it will be necessary, as before stated, to leave the experiments with their results as described to the consideration of the reader, and permit him to deduce his own conclusions.

Le Roy D. Weld.

Iowa State University.

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*ARE THE TREES ADVANCING OR RETREATING UPON THE NEBRASKA PLAINS?**

Two years ago I presented a paper before this Section showing that there are reasons

* Read before Section G, Botany, of the American Association for the Advancement of Science, August, 1899.

for believing that the pines of Western Nebraska are advancing eastward in places where the fires have been kept out, and where cattle are not allowed to destroy, and man is himself not too actively engaged in the work of forest destruction. I have made further observations on these western pines, and while I have no doubt that there are places where they are dying out, I am certain that the general rule is that in western Nebraska and portions, at least, of the Black Hills of South Dakota, they are tending to advance, and that in many places they are actually advancing at a rate sufficiently rapid to be easily observed.

I have been studying the tree areas of eastern Nebraska, also, and find evidence which is still more conclusive that they are advancing with a good deal of rapidity. My personal observations have been in so many localities that it is impossible to specify them in detail in this paper. They involve most of the counties in eastern Nebraska. In practically every case where our travels up the streams, passing out to the side branches, to the little temporary rills which water the upper basins, the trees are of smaller size, and are much younger. It is a very rare occurence to find large trees near the upper end of a forest belt. I have seen a few of such cases, but their rarity is such that one is always surprised when they are found. The general rule is that near the upper limit of the tree area there are many shrubs and mingled with them many young trees no larger than those which under cultivation are known to be not more than fifteen to twenty years old. I may cite the following localities from my notes: (1) on the head waters of Oak Creek in Butler County, (2) headwaters of the Blue River in Seward and Hamilton counties, (3) headwaters of Weeping Water Creek, in Cass County, (4) along small streams in the Loup Valley, (5) along the small streams north of the Platte in Sarpy County, (6) headwaters of the little Nemaha Creek in Nemaha County.

I have asked some of the older settlers of the State in regard to this matter, and invariably they tell me that the trees have advanced up the valleys. One man says: "in our neighborhood the native timber has crept up the water courses in some places a mile or more, and in other places it has widened out from near the stream banks," and again in referring to a particular spreading area he says: "in the places where we played in the 'buffalo wallow' twenty-five years ago, there are now many large trees."

Another says that in 1872 very few of the 'draws' (*i. e.*, ravines) had any trees in them, but now where fire is kept out all are filled with timber. He says that on his farm which was originally swept with prairie fires, "I had a 'draw' where water was half the year, in which in 1883 there were no trees of any kind, while now there are willow, cottonwood, box elder and elms," and again, "the timber belt along the Nemaha River has widened from a hundred feet to half a mile and in some of the 'draws' it has run up from half a mile to a mile."

Another man speaks of a spot where "there is at present a fine lot of young timber of oak and hickory, where in 1876 there was nothing but brush; it is fully one hundred yards further up the stream than it was in 1876." He cites another case where the timber area has gone 'nearly half a mile up the stream.' He says that a fine grove of native timber through which I had passed a day or two before "was a brush patch in 1874, very few of the trees then being large enough for fishing poles," while now many of the trees are thirty or or more centimeters in diameter.

Another observer records a grove consisting principally of oak trees from 15 to 30 centimeters in diameter and 18 to 20 me-

ters in height, occupying an area which a little more than forty years ago the owner used for a hay meadow.

I need not cite further cases. No one who has seen and studied the forest areas in eastern Nebraska, will be able to doubt that they are spreading where they are given a fair opportunity and are not prevented by man or his domestic animals.

Charles E. Bessey.
The University of Nebraska.

PRELIMINARY NOTE ON NEW METEORITES FROM ALLEGAN, MICHIGAN AND MART, TEXAS.

A little after 8 o'clock on the morning of July 10, 1899, there fell on what is locally known as Thomas Hill, on the Saugatuck road, in Allegan, Michigan, a stony meteorite, the total weight of which cannot have been far from 70 pounds, although unfortunately it was badly shattered in striking the ground and its exact weight can never be known. The main mass of the stone, which came into the possession of the National Museum, weighed 62½ pounds, with an additional fragment weighing about 1½ pounds. These with a 4 pound fragment sold to other parties, and very many small bits stated as varying from the size of a pea to that of a hickory nut, carried away by school children and others, would readily bring the total weight up to the figure mentioned. According to the as yet unverified statement of a paper, the fall was accompanied by a 'sudden report, like that of a distant cannon,' this being immediately followed by a rumbling rushing noise similar to distant thunder with the addition of a hissing noise. Eye witnesses of the fall describe the stone as descending in a nearly vertical direction with an apparently slight incline from north to west. A slight bluish tinge and hazy appearance was noted, but no luminosity, though that the stone must have been highly heated in its passage through the atmosphere is proven by its being completely covered by a beautiful black crust, of about 2 mm. thickness. However this may be it was evidently scarcely more than warm when it reached the surface of the ground, for fibers of dry grass, leaves and roots which became firmly attached to its surface through impact, or even driven into crevices formed by the shock of striking the ground, were not charred in the least. The stone is reported to have been about 18 inches long and 12 inches thick, and to have buried itself in the ground by 18 inches where it fell. It was immediately exhumed, and is stated to have been 'still warm' when placed in the show windows of Messrs. Stern & Company, local clothing dealers.

The stone as received at the Museum is polyhedral in outline, one end badly shattered, the larger surfaces often somewhat convex, and as above noted covered with a thin black crust which is irregularly checked by contraction and the shock of the fall. The structure is chondritic, and the essential constituents olivine and an orthorhombic pyroxene (enstatite), together with very finely disseminated metallic iron and undetermined sulphides. A causal inspection fails to make certain the presence of feldspars. The stone therefore belongs to group 29, Kügelchen Chondrit (Cc), of Brezina. The texture is very fine, and uniform throughout, the chondrules, often beautiful spherical, rarely exceeding 2 mm. in diameter. These are sometimes wholly of radiating enstatites, or again of idiomorphic olivines in a black glass. The mass is very friable, and though beautifully fresh and unoxidized, falls away readily to sand when pressed between the thumb and fingers.

As stated in Science for November 10th, the stone will be analyzed and studied microscropically, after which it will be in

part broken up and offered in exchange for other materials of like nature. It will be known as the Allegan meteorite.

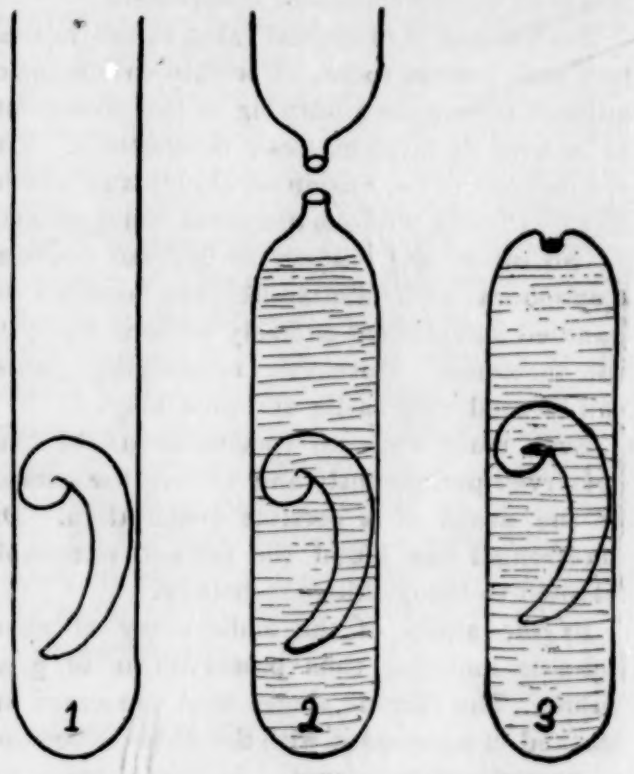
The second meteorite to which I have referred, is an iron, the main mass of which is now in the possession of Baylor University, Waco, Texas. It was found early in 1898, on Vaughn's farm, near Mart, in McLennan County. The iron weighed originally 19¾ pounds. The shape is an irregular oval, some 21.5 x 15 x 8.5 mm. in greatest dimensions, with two deep pits on one side. It was not seen to fall and is somewhat oxidized exteriorly. When cut and etched it shows well the Widmanstätten figures, and the presence of numerous spots of troilite scarcely a millimeter in diameter. This will be known as the Mart iron. Both the iron and the Allegan stone will be analyzed in the laboratories of the United States Geological Survey.

GEORGE P. MERRILL.

PERMANENT PREPARATIONS IN HERMETICALLY SEALED TUBES.

THE method of keeping various animals for demonstration and illustration in hermetically sealed tubes here to be noted has been in use in my laboratory for several years and proven itself so convenient and useful that I feel if it has ever been advocated before (of which I am not cognizant), it deserves revival, hence this note.

In brief the method is as follows: Glass tubing of a size just admitting the specimen is selected considerably longer than the final sealed tube is to be. One end is closed with or without a foot. The tube is then filled with 80% (or 70%) alcohol and the specimen is introduced, allowing it to drop down or carefully working it down the tube. Nearly all the alcohol is then poured off (Fig. 1). Specimens too delicate to admit of this must, of course, be kept covered with alcohol and the final tube be somewhat longer than necessary. The tube is now drawn to a point at some distance from the object and is broken off at the narrow neck (Fig. 2) so as to leave as small an opening as possible through which the tube can be filled up to or even above the shoulder of the drawn end. When the tube is filled the end is sealed in the Bunsen flame (Fig. 3). For filling the tube



finally one needs a 'tube funnel' with a long small end that can be inserted into the neck of the tube.

Care must be taken to get the tube out of the flame before the expansion of the vapors becomes too great. When quickly done the sealed end will often be invaginated by the pressure from without, thus making an end not liable to have the button or bead broken off. In heating the tube after it has contained alcohol inflammable vapors will, of course, be formed. These are usually driven off with an explosion that one soon learns is not at all dangerous.

The secret of success lies in as small a neck as will admit filling and a strong heat applied quickly at the very end.

I have found Flemming's mixture of alcohol, glycerine and water usually better than pure alcohol. This mixture vaporizes less rapidly and as is well known keeps objects in excellent consistency.

For objects to be viewed only from one side or where two specimens, one for a dorsal view and one for a ventral view, can be used, the introduction of a strip of milky or black glass as wide as the diameter of the tube or a trifle less is an improvement for observation.

The method is of special value in the laboratory and lecture room. For toto specimens of animals (or organs admitting of this treatment) to be used by large classes it is excellent. The specimens can be examined closely and can be handled freely without danger of being ruined. In no other way known to me can medusæ, ctenophora and similar delicate animals be handled and studied so freely without injury to the specimen. Moreover, magnifying glasses can be used very easily and profitably.

Even many museum specimens can be thus preserved permanently and relieve the curator of the dread of a possible evaporation. Dr. MacDougal has found the method admirably adapted to many things in botany.

In the study of the embryology of many animals material thus preserved is of great value. The various stages thus preserved are marked in agreement with the series of sections of corresponding stages. In many cases the specimens can be stained and put up in balsam or damar or any other mounting medium for transparent objects. Such preparations in connection with serial sections are often invaluable and to the student are always a help well worth having on hand.

After I had used round tubing for some time it occurred to me oval tubing might be better because it would magnify and distort the objects less. The experiments made with large pig and chick embryos do not, however, favor the oval tubing, which, moreover, is more expensive than the circular tubing. Professor MacDougal, however, prefers it for some of his plant preparations.

Various details, such as mounting and labelling the tubes for the museum, suspending the specimen by means of a fine wire, etc., must be left to individual genius, likes and dislikes.

Henry F. Nachtrieb.

University of Minnesota.

SCIENTIFIC BOOKS.

Methods of Knowledge; an Essay in Epistemology. By Walter Smith, Ph.D., Professor of Philosophy in Lake Forest University. New York, The Macmillan Co. 1899. 12mo. Pp. xxii + 340.

Although Locke must be regarded as the founder of the philosophical discipline known variously as Epistemology, Noëtics, Theory of Knowledge, it remains true that thinkers who use English have lagged behind their German brethren in cultivating its special field. Thanks to Kant, to the renewed interest in his work after 1860, and to the direct influence of the particular sciences—which brought German thought back to Locke just at the moment when Britain and the United States were going to school with Hegel—Epistemology achieved an importance through writers like Schuppe, Cohen, Riehl, Avenarius, Busse, and to some extent, Lotze and Wundt, such as it has never enjoyed with us, and in all likelihood, will not soon gain. Professor Smith's work has, therefore, a place to fill; moreover, the author succeeds in presenting some fresh, if not striking, ideas.

Yet, no matter how favorably one may be inclined to view it, Epistemology suffers still from several capital defects. The delimitation of its precise sphere cannot be called complete by any means. Its relation to logic remains a moot point. Its commerce with psychology, and particularly its debt to psychological methods are undetermined or, at all events, subject to large variation of view. While, once more, even British experts, who have not found so much reason to trouble about its province as their German colleagues, have deemed it necessary to execute some excellent wrangling over its relation to metaphysics. Traces of this dispute remain in the work before us. The weaknesses of Dr. Smith's book appear to be direct products of the two last points. His epistemology, by accident or design I cannot profess to determine, overlaps the psychological sphere extensively. Possibly, one ought to forgive this tendency, because it imparts concreteness to abstract investigations of an exceedingly difficult kind. Again, his conception of the rela-

tion of epistemology to metaphysics, in so far as it crops out, seems to me to be of a distinctively dogmatic character; dogmatic in the pre-Kantian sense. But this criticism, as Dr. Smith, and everybody else must be aware, depends greatly on point of view. And for myself, I am unable to see how epistemology and metaphysics can be disjoined as they appear disjoined here; especially, I must demur strongly to Dr. Smith's pronounced tendency to substitute epistemology for metaphysics in relation to some fundamental problems. I am aware that this is a popular direction at present; but this only emphasizes its temporary character.

The central portion of the work consists of a plain, straight-forward consideration of what might be called the law of homology, in some of its psychological aspects. 'Like is known by like,' and therefore, 'sympathetic imitation' must be regarded as the main and most adequate method of knowledge. Throughout this discussion the proper problem of epistemology, that of the relativity of human knowledge, is submerged, and a factor in experience, which no one would seek to deny, but which falls essentially within the purview of psychology, is put forward as if it furnished at once the ideal and the method. Knowledge is defined as "the presence in the mind immediately, or in copy of that which constitutes objects" (35), evidently on the tacit understanding that this position does not involve dualism, with its resultant scepticism. Just before enunciating this definition, Dr. Smith sums up the merits and defects of other theories of knowledge, without suspecting, however, that the emphasis on the one hand, between subject and object as different, and on the other, the stress on self-knowledge can be traced to an ultimate relativity, a *datum*, if you please so to call it, which is at once the justification of the existence of epistemology and the source of its problem. The dualistic implications of Dr. Smith's standpoint make themselves felt, and naturally, all through. Towards the close they at length become quite explicit. "It is the function of knowledge to equate itself with its object" (266); and on the next page, Dr. Smith quotes, with apparent approval, Mr. Spencer's declaration, "the perception of relations is not the perception of the things themselves." Provided 'perception' be taken in the same sense in both clauses, can such a form of words be said to express anything thinkable by man? Just because epistemology *is* a science with a problem and a solution for it, things cannot be set over against relations and apart from them in this airy fashion.

Although the book is not an epistemology and even illustrates a kind of philosophical backsliding, sporadic now, it presents its good points. The chapter on 'Sympathetic Imitation in Art' contains some admirable reflections; the fatality of hurried systematization is pressed home well, and the entire argument is marked by the presence of an all-round culture very refreshing in these days of one-eyed specializing. As has been indicated, Dr. Smith has not embraced the inviting opportunity to contribute an authoritative work in English to epistemology. He has done appreciable service, nevertheless, by entering a series of *caveats* which some eager spirits would do well to bear in vivid remembrance.

R. M. WENLEY.

UNIVERSITY OF MICHIGAN.

Die Kontinuität der Atomverkettung ein Strukturprinzip der lebendigen Substanz. By DR. GEORG HÖRMANN. Jena, Gustav Fischer. 1899. 3 M.

That such structures as nerves, or even an entire animal, might be regarded as single, huge, chemical molecules was an hypothesis advanced by E. Pflüger a quarter of a century ago. Observation and speculation since have almost unanimously tended toward the prevalent morphological conception of living matter as an aggregate of separate units, while Pflüger's idea has lacked support. In the present essay we find an interesting attempt to extend and to develop Pflüger's hypothesis by logical reasoning illustrated by diagrams.

The author would have protoplasm a net work composed of living matter, with its meshes filled by the various liquids, etc., that go to make up the complex whole.

This network is molecular, invisible, purely hypothetical. The living part of organisms is,

in a sense, solid not liquid; but as it is made up of atoms joined into the molecular meshwork only by their mutual chemical affinities, it is possible for various physical agents to interrupt the continuity of the mass and to make it act somewhat in the manner of a liquid, to become subject to surface tension laws, etc. The solidity is not that of cohesion, but only the result of the chemical attractions that tend to hold together the elements in the complex molecular net against forces that might tend to disturb the continuity.

A cell is a continuous net work made of molecules joined in chains; the members of the chains are different within the nucleus from those outside the nucleus, but there is no break in continuity from one region to the other.

Approaching the problem from the physiologist's point of view, the author devotes his discussion chiefly to phenomena of nerve, muscle, and electrical organ. A nerve is conceived as containing rows of living, conductive molecules surrounded by various liquid and emulsive substances. Each component molecule is joined to its fellows in the row by the affinity of some of its atoms. Progressive chemical action between successive molecules in the chain and the environing materials constitutes the change that travels as a nerve impulse.

In muscle similar chains of conducting molecules have connected with them, as additional mechanisms, special contractile molecules, which owe their change of shape to chemical rearrangements.

Electrical organs easily lend themselves to an application of similar diagrammatic formulations.

Strange as it may seem the phenomena of the active flowing of protoplasmic streams in those exceptional water-plants, Stoneworts, are made foundation stones in the author's attempt to realize protoplasm as a solid, continuous, gigantic molecule. His previous valuable contribution to the physiology of these plants (Studien über die Protoplasmaströmung bei den Characeen. Jena, Gustav Fischer. 1898) resulted in the discovery of marked agreement in the conductive mechanisms in nerve, muscle and the cells of *Nitella syncarpa*. The motor mechanism in the last, however, he concludes, is different from that in muscle. Both the constant rotation of the moving layer of protoplasm and the very remarkable separate rotation of separate chlorophyll grains, which the author is sure he has seen, are conceived of as results of successive making and breaking of chemical union along the surface of contact of moving and non-moving protoplasm.

E. A. Andrews.
Johns Hopkins University.

A Dictionary of Birds. By Alfred Newton, assisted by Hans Gadow. Cheap issue, unabridged. London, Adam and Charles Black. 1893–96. Pp. xii + 1088. Price, $5.00.

Good wine needs no bush and Newton's Dictionary of Birds needs no recommendation, the more that it was fully reviewed in Science upon its first appearance.

There are, however, many who will welcome this edition, not only for its greatly reduced price, but for its convenient size, since without sacrificing a word of the text the use of thin, but good paper, makes this book a compact volume. Few there are who have Professor Newton's wide acquaintance with the literature of ornithology and the bibliographical references alone are sufficient to make the work a necessity, not only in the library of the working ornithologist, but of the general reader, while the contributions of Dr. Gadow constitute a text-book on the anatomy of birds. Our younger ornithologists will do well to keep this book within reach and consult it often, if only to fully appreciate that scientific facts may be presented in the best literary form.

F. A. L.

BOOKS RECEIVED.

A Treatise on Crystallography. W. J. Lewis. Cambridge, England, University Press. 1899. Pp. xxii + 612. 14s.

The Strength of Materials. J. A. Ewing. Pp. xii + 246. Cambridge, England, University Press. 1899. Pp. xxii + 612. 12s.

Electric Wiring, Fittings, Switches and Lamps. W. Perren Maycock. London, Whittaker & Co.; New York, The Macmillan Co. 1899. Pp. xv + 446. $1.75.

Botany for Beginners. ERNEST EVANS. London and New York, The Macmillan Company. 1899. Pp. vi + 286.

Magnetism and Electricity for Beginners. H. E. HADLEY. London and New York, The Macmillan Company. 1899. Pp. viii + 327.

Ascidia. W. A. HERDMAN. Liverpool Marine Biology, Memoirs I. Liverpool, T. Dobb & Co. 1899. Pp. v + 52 and 5 plates. 1s. 6d.

Report of Fur Seal Investigation, 1896-1897. Part III. *Special Papers relating to the Fur Seal and to the Natural History of the Pribilof Islands.* DAVID STARR JORDAN. Washington, Government Printing Office. 1899. Pp. xii + 629.

On the Building and Ornamental Stones of Wisconsin. ERNEST ROBERTSON BUCKLEY. Madison, Wis., Published by the State. 1898. Pp. xxvii + 544.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Geology for July–August contains the following articles:

'A new Analcite Rock from Lake Superior,' by A. P. Coleman. On the north shore of Lake Superior in the vicinity of Heron Bay, Dr. Coleman recently discovered a series of dikes, one of which proved to be an analcite rock. It has some peculiarities of texture, contains about 52 per cent. silica, and is related to basic syenites. The name Heronite is suggested. A complete analysis is given.

'Corundiferous Nepheline Syenite from Eastern Ontario,' by A. P. Coleman. Dr. Coleman gives some additional notes and facts about this peculiar rock.

'The Effect of Sea-Barriers upon Ultimate Drainage,' by J. F. Newsom. This very interesting and suggestive paper shows how the barrier beaches and their attendant sounds may, when the coast line is elevated, cause the main artery of the resulting drainage to run parallel with them, and at right angles to the subordinate tributaries.

'Season and Time-elements in Sand-plain formation,' by Myron L. Fuller. From a close study and very ingenious interpretation of the Barrington sand-plain and its attendant clays, on Narragansett Bay, R. I., and with auxiliary inferences about the effects of the seasons on the discharge of a glacier, the author makes a computation of the time required to yield the observed phenomena. The results check up very well with general criteria, and the paper is an interesting attempt to give quantitative definition to otherwise hazy themes.

'Petrographical Province of Essex Co., Mass,' VI., 'General Discussion and Conclusions,' by H. S. Washington. In this the concluding instalment of the series of papers contributed by Dr. Washington to recent numbers of the *Journal of Geology*, the author generalizes regarding the peculiar chemical features and mineralogy of the Essex County rocks. He also discusses their bearings on the general question of magmatic differentiation. Dr. Washington concludes that differentiation occurred and that it was laccolithic rather than abysmal.

'A Peculiar Devonian Deposit in Northeastern Illinois,' by Stuart Weller. A small triangular mass of rock containing Devonian fossils has been uncovered in a quarry of Niagara limestone at Elmhurst, Ill. It appears to have been a hole in the limestone when the latter formed the sea bottom in Devonian time, and to have been a resort of fish whose remains have been preserved.

'Descriptions of New Species of Diplodus teeth from the Devonian of Northeastern Illinois,' by C. R. Eastman. The paper describes the fish, the discovery of whose remains is detailed in the previous paper.

'Dipterus in the American Middle Devonian,' by J. S. Udden. This short paper describes and figures a Dipterus tooth recently found in the limestones at Fairport, Muscatine Co., Iowa.

Under the 'Studies for Students,' Stuart Weller gives an excellent sketch of a 'Century's Progress in Paleontology.'

The number closes with editorials and reviews.

THE October number of the *Bulletin of the American Mathematical Society* contains a Report of the recent Summer Meeting of the Society, by the Acting Secretary, Professor Thomas F. Holgate; the 'Report on the Recent Progress in the Theory of Linear Groups,' presented before Section A, of the American Association, at the Columbus Meeting, by Professor L. E. Dickson; several 'Shorter Notices'; 'Notes'; and 'New Publications.'

The November number of the *Bulletin* contains a report of the meeting of Section A, of the American Association, by Dr. G. A. Miller; a review of Harkness and Morley's 'Introduction to the Theory of Functions,' by Professor Oskar Bolza; a review of McAulay's 'Octonions,' by Professor A. S. Hathaway; 'Theses in Mathematics at the University of Paris,' a review by Professor E. O. Lovett of five theses, presented to the Faculty of Sciences of the University of Paris, 1897–8; 'Notes'; 'New Publications.'

Bird-Lore for October contains an article by Dr. J. A. Allen on the *American Ornithologists' Union* illustrated by a full page plate showing the twenty-four founders of the Union. It contains portraits of Baird, Robert Ridgway, Elliott Coues, J. A. Allen, C. Hart Merriam, William Brewster and other prominent ornithologists.

It is stated in *Natural Science* that the Quebec government has withdrawn the grant made to defray the cost of publishing the *Canadian Record of Science*. The Natural History Society of Montreal appeals for help to continue the journal.

SOCIETIES AND ACADEMIES.

THE NATIONAL ACADEMY OF SCIENCES.

The Academy held its autumn session at Columbia University on Tuesday and Wednesday, November 14th and 15th, the following members being in attendance: Cleveland Abbe, George F. Barker, C. E. Beecher, A. Graham Bell, John S. Billings, Henry P. Bowditch, William H. Brewer, George J. Brush, Charles F. Chandler, Cyrus B. Comstock, Edward S. Dana, Samuel F. Emmons, Wolcott Gibbs, Arnold Hague, Charles S. Hastings, Edward S. Holden, Richmond Mayo-Smith, Albert A. Michelson, Simon Newcomb, Charles S. Peirce, Frederick W. Putnam, T. W. Richards, Ogden N. Rood, A. E. Verrill, Charles D. Walcott, E. B. Wilson, Horatio C. Wood, Robert S. Woodward and Arthur W. Wright.

At the business session Professor H. P. Bowditch presented the report of the delegates to the Wiesbaden Congress to consider the establishment of an International Scientific Association.

The scientific program was as follows:

Variations in Normal Color Vision, by Ogden N. Rood.

The Time of Perception as a Measure of Difference in Intensity; Relations of Time and Space in Vision (by invitation), by J. McKeen Cattell.

The Electro-chemical Equivalents of Copper and Silver, by Theodore William Richards.

Recent Results of the Henry Draper Memorial, by Edward C. Pickering. Read by Professor G. F. Barker.

The Statical Properties of the Atmosphere, by R. S. Woodward.

The Hydrogen Vacua of Dewar, by George F. Barker.

A Direct Proof of the Effect on the Eulerian Cycle of an Inequality in the Equatorial Moments of Inertia of the Earth, by R. S. Woodward.

The Definition of Continuity (by title); Topical Geometry, in General (by title): The Map-coloring Problem, by Charles S. Peirce.

Memoir of W. A. Rogers as a Physicist (by title), by E. W. Morley.

BIOLOGICAL SOCIETY OF WASHINGTON, 311TH MEETING, SATURDAY, NOVEMBER 4TH.

Dr. L. O. Howard, under the title 'Preliminary Notice of an Investigation of the Insect Fauna of Human Excrement,' exhibted a series of dipterous insects reared from human excrement, and stated that having been interested in the published accounts in the medical journals of the autumn of 1898 of the supposed carriage of typhoid germs by flies in army camps, and realizing that no careful investigation of the insect fauna of human excrement had been made by entomologists, he had begun such an investigation in January, 1899. During the year many thousands of specimens of insects had been reared from fecal matter, and had been collected in privies and on excreta in the field, largely in the vicinity of Washington, but also in other parts of the country at different points, from Porto Rico to the State of Washington. Up to the present time, 138 distinct species of insects had been determined to frequent human excrement, including 77 distinct species of *Diptera*,

and 45 distinct species of insects have been reared from the excrement in which they passed their larval stages, and these include 35 distinct species of *Diptera*. Similar collections and observations have been made upon flies frequenting kitchens and dining rooms in different parts of the country. All of the material has been studied and specifically determined. The investigation will be continued and the results published next year.

Mr. Wm. H. Dall gave some informal 'Notes on Honolulu and the Hawaiian Islands,' from observations made there during a recent visit. He described the physical features of Oahu and their effects upon the climate, the characteristics of the flora and fauna of the city of Honolulu, laying particular stress upon their almost exclusively exotic character, and gave an account of the Bishop Memorial Museum, an institution reflecting the greatest credit upon the founder who endowed it, the board who have managed the investments, and the Director, Dr. W. T. Brigham, to whose energy, efficiency and wide knowledge is largely due the fact that Honolulu now has a Museum of Polynesian Ethnology and Natural History in many respects unique and which would be a credit to any city in either hemisphere.

Mr. G. K. Gilbert described the state of preservation of the celebrated 'Submerged forest of the Columbia River,' between the Dalles and the Cascades. From data connected with the geological history of the region he inferred that the submergence had taken place at least three hundred and fifty years ago. Since that time the roots of the trees, whose stumps still stand, have been continuously under water, but the upper portions of the shafts have been annually bared at low water and covered during flood. Despite this alternation of condition, which generally induces rot, the trunks are sound. The bark has disappeared, and several inches of the wood have wasted away, but what remains is firm and retains its natural color. Mr. Gilbert suggested that the continuous submergence of the roots may have operated in some way as a favorable condition, but it was the opinion of botanists present that the roots must have ceased to function immediately upon the death of the tree, and that the preservation of the trunks was merely an extreme illustration of the durability of the wood of the species *Pseudotsuga douglasii*.

O. F. COOK,
Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 505th meeting of the Philosophical Society of Washington was held October 28th, at the Cosmos Club. Informal communications were made by Dr. Artemas Martin, on a method of extracting roots by successive subtractions and by Mr. C. K. Wead, on Museum Labels. The Director of the Geological Survey, Mr. C. D. Walcott, gave the results of his observations on a recent 'Geological Trip to Newfoundland,' and Mr. C. K. Wead described 'Some Arab Musical Scales.' The facts presented were made accessible by Land's French Translation of Al Farabi's 'Treatise on Music,' and confirmed in part by other authorities. The principal scale for the Lute was shown to be peculiarly dependent on the length of the neck of the instrument in comparison with the size of the player's hand: the five strings were tuned in fourths, and the frets were located partly by geometrical principles, and partly by bisections of distances; so ten notes were provided on each string, giving twenty-two to the octave. Later theorists reduced these numbers to seven and the much-discussed seventeen. The Modes each consisting of a selection of seven or eight of these notes were also dependent on the structure of the lute.

Some long-necked Tambours had entirely different scales tuned by the use of two strings, being built up by musical addition or subtraction of equal intervals, *i. e.*, by a step-by-step method—these scales had seven to ten notes at intervals of about half a semitone. Our current theories of the scale are utterly inapplicable to these facts.

E. D. PRESTON,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE NEED FOR A CLASSIFICATION OF PREHISTORIC IMPLEMENTS.

ABOUT a year ago Mr. A. E. Douglas, of the American Museum of Natural History, published a paper in which he urged the need of an

archæologic nomenclature. He presented a table in which he showed the distribution of certain types and forms of artifacts.

Dr. Thomas Wilson, of the Smithsonian, has issued a number of reports in which he classifies and subdivides the multitudinous flint tools of the United States. Aside from this and what has been done by Messrs. Holmes, Fowke, Rau, Ab bott and others, the various museums and individuals have confined themselves to the chronicling of explorations rather than to the detailed study of objects. Some of the more remarkable art specimens in copper, clay and shell have been reported upon. But I think it is no exaggeration to say that museums direct their attention to the accumulation of vast stores of material. This is apparent to archæologists visiting any of the five larger museums.

I agree with Mr. Douglass that too little attention is given towards the study of these interesting implements. By comparison and a careful study of localities and the objects themselves, much is to be learned.

I have begun several MSS. upon 'ornamental and ceremonial stones,' and 'implements and utensils,' etc. I shall be glad to have photographs, drawings or descriptions, together with observations and opinions from persons interested in prehistoric archæology. I shall feel encouraged if a more serious study of stone, bone, shell and clay objects results from the undertaking, although other observers may take exceptions to my views. An exchange of correspondence is desired.

Warren K. Moorehead.
Saranac Lake, N. Y.

NOTES ON INORGANIC CHEMISTRY.

In the *Zeitschrift für praktische Geologie*, H. Oehmichen describes some recently discovered auriferous cobalt ores in the Kruis river district in the Transvaal. The ore, which is found associated with diabase rocks, is exclusively smaltite, with its decomposition products, as erythrite, and carries gold to the amount of about 60 grams per ton. The gold seems to be in the smaltite, as no trace of free gold is found. Five kilometers further west is another deposit of pockets of smaltite, in a gold bearing quartz, the whole assaying 400 grams per ton. Here ninety per cent. of the gold is contained in the smaltite. These deposits promise to have a very considerable value.

The subject of the distribution of the so-called rare metals continues to interest chemists and in the same journal is an extensive paper by J. H. L. Vogt on the distribution of vanadium. A very considerable portion of the paper is taken up by a review of Hillebrand's paper (published last year in the *American Journal of Science*) on the same subject. From Hillebrand's investigations and his own, Vogt concludes that the average amount of vanadium in the solid crust of the earth is between 0.0025% and 0.005%. Vanadium is thus decidedly less abundant than titanium (which occurs to the extent of 0.3%), phosphorus (0.09%), manganese (0.075%) and sulfur (0.06%); and also rarer than barium (0.03%), zirconium (0.01–0.02%) and chromium (0.01%). It falls near lithium, strontium and nickel, each of which occurs to the extent of about 0.005%, but is probably somewhat less abundant than these elements. Still rarer elements are cerium and yttrium (each less than 0.001%), cobalt (0.0005%) and thorium (0.0001%). Zinc and glucinum are somewhat less rare. Vanadium is generally found in the basic eruptive rocks, while columbium and tantalum, which resemble it are found especially in granitic rocks. The elements of Group VI. show a similar condition, for chromium is found in basic rocks, while molybdenum, tungsten and uranium are more generally associated with acidic rock masses. It might be added that these occurrences are not unnatural, inasmuch as vanadium and chromium are themselves much less positive than the elements of the same groups with higher atomic weight.

There is given in a recent number of the *Oesterreichische Zeitschrift für Berg- und Hüttenwesen* a description by E. Priwoznik of the Austrian mint methods of parting platiniferous gold and silver. The material is first digested with dilute nitric acid (1.109) in which only a trace of platinum dissolves. The residue is then treated with a somewhat diluted aqua regia in which the gold dissolves readily, while the platinum is only very slightly soluble. When silver is present a coating of silver chloride is gradu-

ally formed which impedes the solution of the gold. In this case the silver chlorid coating must be from time to time dissolved off by ammonia. The small amount of platinum in the gold solution is precipitated by sal ammoniac. When much silver is present the alloy is fused with zinc and then treated with sulfuric acid before the above process.

THE atomic weight of palladium has been several times redetermined in the past few years, but with results varying from 105.75 to 107.18. No cause has been discovered for these discrepancies. The figure accepted by Clark is 106.36, by Richards 106.5, and by the German Committee 106.0. Three new series are described by W. L Hardin in the *Journal* of the American Chemical Society, in each case the compound used being one not hitherto used for atomic weight determination. The palladium itself was most carefully purified. The results are as follows: Using diphenylpallad-diammonium chlorid, mean of seven determinations 107.006; using diphenylpallad-ammonium bromid, mean of five, 107.036; using ammonium palladium bromid, mean of four, 107.00; mean of all, 107.014. It will be seen that this figure is decidedly higher than that usually received; it is, however, in close agreement with that obtained by Keller and Smith (107.18 as a mean of nine determinations) by the use of palladdiammonium chlorid.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

INTERNATIONAL METEOROLOGICAL COMMITTEE.

AT the meeting of the International Meteorological Committee held at St. Petersburg, September 2–7, 1899, it was decided that the Sub-Committee on Terrestrial Magnetism and Atmospheric Electricity should be maintained as a distinct organization, under the direction of the International Committee. The committee recommended that meteorological institutions should take part in observations of earthquake phenomena, and in the matter of Antarctic exploration expressed the opinion that it is highly desirable (1) that the results of these explorations should be completed by data from the observatories already existing in the Southern Hemisphere and by those made on board vessels traversing the southern oceans; (2) that new meteorological stations should be established in the southern part of the Antarctic regions, and especially that magnetic observations should be organized; (3) that magnetic determinations over the whole globe should be made simultaneously with those made during the expeditions. The subjects of publishing tables of diurnal range of temperature for each country in a special form, the importance of actinometric observations, the multiplication of observations with the hair hygrometer in place of the wet-bulb thermometer, the laying of a cable between Iceland and Europe, and the publication of an international periodical weather report to contain ten-days means for about 100 stations, were discussed, but no definite action was taken regarding them. It was decided that the International Committee and all the sub-committees should meet in Paris in 1900, immediately after the Meteorological Congress. *Nature* of October 19th contains a brief account of the Proceedings at the September Meeting of the International Committee.

THE TEXAS FLOODS OF JUNE 27 TO JULY 15.

A report on the flood in the Brazos river valley, Texas, at the end of June and the beginning of July last appears in the *Monthly Weather Review* for July (issued September 22d). The writer, Dr. I. M. Cline, Local Forecast Official of the Weather Bureau at Galveston, states that the heavy rains resulted from a semi-tropical storm which moved northward from the central portion of the Gulf of Mexico. The storm was first noted on the morning weather map of June 26th, and moved inland during the night, dying out as it advanced. An anticyclone moving southward from the northwest opposed the Gulf storm on June 27–28, these being the pressure conditions which prevailed during the occurrence of the rains. Two of the heaviest rains recorded during the 72 hours ending at 8 A. M., June 28th, were as follows: Alvin, 7.27 ins.; Brazoria, 7.83 ins. During the 72 hours ending at 8 A. M., June 29th, some of the heaviest rainfalls were: Columbia, 8.06 ins.; Danevang, 11.07 ins.; Rock Island, 10.15 ins., and during the 72 hours ending at 8 A. M., June 30th, Brenham had 19.99 ins-

The rain gauge at Hearne overflowed at 24 inches. The floods resulting from these extraordinary rainfalls were extremely destructive, as readers of SCIENCE will doubtless remember. Between 30 and 35 lives were lost, and crops and other interests suffered to the extent of millions of dollars.

VOLCANIC SMOKE AND THE PREVAILING WINDS.

The *Monthly Weather Review* for July contains an interesting note contributed by Curtis J. Lyons, of Honolulu, on the course taken by the smoke during the recent eruption on the island of Hawaii. This smoke rose to a height of about 30,000 ft. above sea level, and then floated off to the northeast, being carried in a horizontal direction by the anti-trades. It then sank to sea level about 600 miles from Hawaii, and was brought back by the northeast trade wind, covering the entire group of islands with heavy smoke fourteen days after the eruption. The S. S. *Mariposa*, on her voyage from San Francisco, met the cloud of smoke at the above distance from Honolulu. The smoke was overhead at first, and as the steamer proceeded it covered everything at sea level.

HURRICANE TRACKS IN THE NORTH ATLANTIC OCEAN.

The *Pilot Chart of the North Atlantic Ocean* for November gives the tracks followed by the centers of all the West Indian hurricanes which have occurred in the North Atlantic during the period 1890–1899. It appears from a tabulation of the 25 hurricanes noted during these years that the ideas which were formerly held regarding the recurvature of the storms of a particular month within certain narrow limits of latitude need some revision. The table shows that the hurricanes of September, instead of recurving between latitudes 27° and 29°, as formerly maintained, may in actual practice recurve in any latitude from 20° 20′ N., to 33° 30′ N., while those of October, instead of recurving in latitude 20°–23° N. may continue their northeasterly course until the parallel of 39° is reached.

TORNADO POWER.

As the result of studies of the amount of pressure necessary to bend the rods of certain railroad switch targets, Mr. B. F. Groat comes to the conclusion that the velocity of the wind in the New Richmond, Wis., tornado of June 12th last was 134 miles an hour. Mr. Groat's paper is published in the *Monthly Weather Review* for July.

R. DeC. WARD.

HARVARD UNIVERSITY.

REPORT OF THE PRESIDENT OF COLUMBIA UNIVERSITY.

President Low's annual report to the trustees, after paying a tribute to the memory of Cornelius Vanderbilt and expressing thanks to Professor Van Amringe, who was acting president during his absence as a delegate to the International Conference of Peace, gives a clear and interesting account of the progress and present condition of Columbia University.

The cost of the new buildings and grounds was in all $6,879,011. By the payment of President Low of $600,000, completing his great gift for the construction of the Library, the debt against the new site is reduced to about $2,975,000. There is also a debt against the College of Physicians and Surgeons amounting to about $86,500. Although Columbia University has gained greatly by its removal in many ways, including a large increase to its funds by gifts for the grounds and buildings, it is evident that the interest, even though a large part of the debt has been refunded at 3 per cent., is a serious burden, and President Low states that the growth of the University is necessarily checked until this incubus is removed. As a matter of fact the University did receive liberal gifts during the year; $73,494 for current uses and $490,417 for endowment. The increase of the library during the year was 25,404 volumes.

The growth of the University, since the beginning of Mr. Low's administration nine years ago, is indicated by the fact that in this period the officers of instruction have increased from 170 to 339. This is not due to the multiplication of subordinate officers as the number of professors and adjunct professors has increased from 41 to 84. The number of students has increased from 1,753 to 2,208 although the growth has been checked by increasing the re-

quirements, as by adding a fourth year to the medical course and by reorganization of the Law School. A further growth is represented by the students of Barnard College and Teachers College, respectively 278 and 297, both established at the beginning of President Low's administration and now under the sphere of influence of Columbia University. If 1,173 extension students are added the total number under the immediate influence of the University is 3,985.

Among the important educational advances of the year may be mentioned the creation of a large number of scholarships in the place of free and reduced tuition, the establishment of a professorship of anthropology and an adjunct professorship of mechanical engineering, and the decision to conduct a summer session in 1900.

SCIENTIFIC NOTES AND NEWS.

WE record with great regret the death of Sir William Dawson, the eminent geologist and author, for twenty-eight years principal of McGill University. He was born in Nova Scotia in 1820 and died on November 19th.

THE University of Pennsylvania has appointed a committee to arrange with similar committees of other organizations for a memorial in honor of the late Professor Brinton.

THE Washington *Star* states that the orders recently issued in the case of Professor S. J. Brown, U. S. A., have been modified by the Acting Secretary of the Navy, so as to assign him to duty as astronomical director of the Naval Observatory, to take effect December 17th, instead of making him director of the Nautical Almanac, an office attached to that institution, as originally intended.

A COMMITTEE formed at the Dover Meeting of the British Association is making arrangements for an international meeting of scientific men in connection with the Paris Exposition of 1900. Those wishing to assist in this undertaking should address the assistant secretary, Mr. J. R. Marr, 5 Old Queen Street, London, S. W.

THE third annual meeting of the Society for Plant Morphology and Physiology, will be held, in conjunction with the meetings of the American Society of Naturalists and the Affiliated Scientific Societies at New Haven, on Wednesday, Thursday and Friday, December 27–29th.

FREDERIC W. SANDERS, Ph.D. (Chicago), formerly professor in the University of West Virginia, has been elected President and Director of the New Mexico College of Agriculture and Mechanic Arts and Agricultural Experiment Station at Mesilla Park, New Mexico.

DR. W. H. CORFIELD, professor of hygiene and public health in University College, London, has been appointed to the newly created post of consulting sanitary adviser to the British Office of Works.

MR. HORACE PLUNKETT, M.P., has been appointed vice-president of the new department of Agriculture and Technical Education for Ireland.

WE learn from *Nature* that at the recent annual meeting of the Royal Academy of Medicine in Ireland, the following men of science were elected honorary Fellows of the Academy: Sir J. Burdon-Sanderson, Bart., F.R.S.; Prof. Howard Kelly, Baltimore; Professor Koch, Berlin; Professor Kocher, Bern; Professor Th. Leber, Heidelberg; Sir W. MacCormac, Bart., K.C.V.O., London; Professor Martin, Berlin; Professor Nothnagel, Vienna; Professor Osler, Baltimore; and Sir W. Turner, F.R.S., Edinburgh.

DR. WILLIAM S. CHURCH, President of the Royal College of Physicians, London, has been elected an honorary fellow of University College, Oxford.

THE gold medal of the Highland Agricultural Society of Scotland has been awarded to Professor Cossar Ewart in recognition of his intercrossing and other experiments.

PROFESSOR H. S. CARHART of the Physics Department of the University of Michigan, who, as we have already stated, is in Berlin, has compared the standard Clark cell with the standard of the Physical Technical Institute and found that the electromotive force of the standard Clark cell does not differ more than one in twenty thousand from the average electromotive force of the standard cell of the institute.

Dr. O. von der Heyde, assessor of forestry, in the German Empire, who has been examining the management of forests in India and Japan, is at present in the United States.

We regret to learn that Professor Ernst Mach of the University of Vienna is prevented by illness from giving his lectures this winter.

Dr. Walter J. Hoffman died at Reading, Pa., on November 8th, at the age of fifty-three years. When a surgeon in the U. S. Army he made studies on the North American Indians, and later when connected with the American Bureau of Ethnology published numerous important researches on the subject.

Dr. W. C. Arnison, professor of surgery in the University of Durham, died on November 4th, aged 62 years. He was formerly lecturer in botany and vegetable physiology. He had been president of the section of surgery of the British Medical Association, and was the author of numerous contributions to the medical press.

The death is announced, at the age of 96 years, of Dr. Gonzalo Aróstegui, at one time professor of surgery in the University of Havana.

A memorial of Dr. Müller, who it will be remembered fell a victim to the plague in Vienna on October 23, 1898, was recently unveiled in the quadrangle of the General Hospital of that city. Professor Nothnagel delivered an address.

We learn from *Natural Science* that Dr. Kishinouye and other Japanese zoologists have hired a two-storied building on the shores of the Inland Sea, with the view of converting it into a biological station. Professor J. Ijima has returned from a zoological expedition to Formosa.

Mr. Andrew Carnegie has offered to give $125,000 for a building for the Polytechnic Library Society, of Louisville, Ky., for the construction of a building, provided that the city appropriates at least $10,000 a year for running expenses. He has also offered $50,000 to establish a public library at Houston, Tex., on condition that the city appropriate $4,000 for maintenance.

The Council of the Senate of Cambridge University, having regard to the extensive and valuable collections procured for the University by the Torres Straits Expedition, propose that a further grant of 100*l.* (making 550*l.* in all) be made from the Worts Travelling Scholars' Fund to Dr. A. C. Haddon towards the expenses of the expedition.

Reuter's agency reports that, according to advices received in London, Dr. Donaldson Smith, who left England for East Africa some time ago, has safely arrived at Hargeisa, in Somaliland, with his Somali escort. Dr. Smith, who is accompanied by Mr. Carlisle Fraser, states that it is his intention to push on to Lake Rudolph as quickly as possible and then explore the unknown country to the west. It is, therefore, unlikely that anything more will be heard of the expedition for a considerable time.

Dr. Von Höhnel, professor of botany in Polytechnic Institute at Vienna, has returned from an expedition to Brazil with valuable collections.

Natural Science states that the Danish expedition to East Greenland, under the leadership of Lieut. Amdrup, returned to Copenhagen on September 13th. It had investigated and mapped the tract between 65° 50′ and 57° 22′ N. lat., hitherto unvisited by Europeans. At one time it was inhabited by many Esquimaux, all of whom have now perished. A collection of their skulls and other relics was brought home. Botanical, geological, and zoological observations were made, as well as anthropological measurements on living Esquimaux in other parts. Depots were left at 60° 6′ and 67° and 15′ N. lat.

A steamship has been held in quarantine outside New York City containing two cases of bubonic plague. There was also one death on the voyage. The steamship came direct from Santos, Brazil. It is commonly supposed that there is no chance that the bubonic plague will become epidemic under proper sanitary conditions, but its development in widely separated places causes some apprehension.

The St. Petersburg correspondent of the London *Times* telegraphs that rich auriferous deposits have lately been discovered on the

northwestern shore of the sea of Okhotsk, and have been examined by a commission of mining engineers sent by the Imperial Government to Siberia for that purpose. These deposits will be leased to the highest bidders at a public auction to be held on February 27th next, at the Ministry of Agriculture and State Domains. The agents of the Russian Ministry of Finance abroad are authorized to communicate to intending purchasers the conditions of the sale, and all further particulars concerning the lease of the deposits in question.

THE department of pharmacognosy of the University of Michigan will hereafter grow its plants for use in research work. This is to guarantee abundance and authenticity of the drugs. Several acres of ground will be secured, and the plants which are to be the subjects of investigation will be cultivated in large quantities. The plan is an outgrowth of the botanical gardens which were established three years ago.

AN Ornithological Club, with about fifteen members, has been organized by Mr. W. E. D. Scott, at Princeton University.

WE take the following note from the last issue of *Natural Science:* At a meeting held in The Outlook Tower, Castlehill, Edinburgh, on 14th October, Professor James Geikie, D.C.L., in the chair, an interesting and stimulating address was delivered by Professor Wilbur Jackman, M.A., of Chicago University and Training College, on 'Nature Study, its Methods and Results in School Practice.' Even apart from the able address, which will doubtless be published, the exhibits of notes of work, especially those in water-color, arranged round the room, showed what results await those teachers who have the courage and opportunity to devise courses of nature-study to mitigate the burden of book-work. To many of those present these exhibits and the story of them must have seemed a revelation, but it was interesting to notice that several authorities who took part in the discussion, which lasted for towards two hours after the lecture, reverted to the necessity of 'books.' A guide-book for the teacher may be necessary—not that there is really a lack—but of more books for the scholars there should, in a case like this, be no mention. Owing to the overcrowded audience, an adjournment after the lecture was effected to the Castlehill public shool, where, under the chairmanship of Professor Crum Brown, F.R.S., an interesting discussion was held. To this contributions were made by Mr. Robert Smith, B.Sc., of University College, Dundee, who reported on some nature-study classes which he had conducted, by Mr. Robert Blair, Science Inspector, by Mr. Dunn, H.M.I.S., by Professor J. Arthur Thomson of Aberdeen, by Dr. Maurice Paterson of the Free Church Training College, by Miss Stevenson of the Edinburgh School Board, by Mr. Walter Blaikie, Professor Geddes of Dundee, and others. There was also an exhibition of maps of a botanical survey of Scotland by Mr. Robert Smith, of a cosmosphere by Mr. Walter Blaikie, of a first panel of a proposed spheric atlas by Professor E. Reclus of Brussels, of relief models by Mr. George Guyou, etc. Altogether the meeting was one of considerable educational importance in connection with the teaching of natural science in schools.

ACCORDING to *Nature* the Society of Arts of London planned to open its new session on November 15th, with an address from the chairman of the Council, Sir John Wolfe Barry, K.C.B., F.R.S., in which it was expected that he would develop the subject of his address last year, 'London Communications,' and would make some suggestions as to the practical means of carrying his proposals into effect. The first paper after the opening meeting will be by Mr. D. E. Hutchins, who will draw attention to the want in England of measures for the proper conservation of woods and forests. At the next meeting Mr. Allan Wyon will give a paper, principally of an antiquarian nature, on the Great Seals of England. At the other meetings before Christmas it is probable that Mr. Joseph Cash will describe the substitutes which have recently been introduced to replace silk, and the methods of their production. Mr. F. G. Aflalo will draw attention to the necessity for some legislation to restrict sea anglers from catching immature and undersized fish; and Mr. H. Bloomfield Bare will describe and illustrate the methods, which have recently achieved considerable success in

America, of teaching drawing by the use of the blackboard, both hands being employed. Mr. H. H. Cunynghame, who has devoted a great deal of attention to the subject, will give a course of Cantor Lectures before Christmas on the art of enamelling. It is intended to demonstrate practically the whole process ef enamel-making during the course. The Juvenile Lectures will be by Mr. Herbert Jackson, of King's College, who will lecture on phosphorescence.

UNIVERSITY AND EDUCATIONAL NEWS.

THE San Francisco *Call* says it is understood that the money, amounting to $11,400,000, obtained by Mrs. Jane Stanford for her 285,000 shares of Southern Pacific stock, which she sold recently, will at once be made available for the use of the Stanford University. The Library, the gift of T. W. Stanford, and the Assembly Hall, are now ready for occupancy.

WILLIAM H. WEBB founder of Webb Academy and Home for Shipbuilders, New York city, has by his will left to the Academy the reversion of the larger part of his estate valued at over $600,000. He has also left directly to the Academy his paintings, drawings, books, etc., relating to shipbuilding.

MR. JAMES JENNINGS MCCOMB of New York, one of the founders of the Southwestern Presbyterian University at Clarksville, Tenn., has given $70,000 to the endowment fund, making his contributions amount in all to $100,000.

BROWN UNIVERSITY has received an unconditional gift of ten thousand dollars from the heirs of the late Lucian Sharpe.

THE Rev. John Pike has left the reversion of half his property to found two scholarships in Bowdoin College.

IT is announced that architects' plans are now being considered by the corporation of Yale University for the memorial building which it is planned to erect before the bi-centennial exercises in 1901. The building will contain a dining hall and an auditorium, and will cost $750,000, of which sum over $400,000 has been subscribed. The building will be at the corner of Grove and College Streets.

THE Wilmerding School of Industrial Arts, which the regents of the University of California have established in accord with the will of the late J. C. Wilmerding, will be opened for instruction on January 8, 1900.

A PLAN submitted by Professor Hanus of Harvard University, to the Cambridge School Board, according to which a certain number of Harvard students should be allowed to undertake practice teaching in the public schools, and teachers should have the privilege of taking courses at Harvard, has been rejected by the board.

THE courses of lectures in the sciences at Oxford University for the present term number 41, distributed as follows: physics 6, chemistry 10, geology 3, mineralogy 3, zoology 7, physiology 10, botany 1, anthropology 1. As these courses include both elementary and advanced work, and many of them are only one hour a week, it is evident that Oxford does not compare favorably with the scientific work of other great universities.

THE Archæological Institute of America offers six fellowships for next year. Three for work to be done at Athens and three at Rome. Further information can be obtained from Dr. C. H. Young, Secretary, Columbia University.

MRS. ELIZABETH CARY AGASSIZ has resigned the presidency of Radcliffe College, but has consented to accept the position of honorary president.

DR. H. S. LEAKE has been appointed instructor in anatomy in Williams College, to take the place of the late Professor Woodbridge. Dr. Leake is a graduate of Williams College and of the College of Physicians and Surgeons, New York City.

IN accordance with the new law permitting French universities to establish professorships for which the means are at hand, two new professorships have been established under the faculty of sciences at the Sorbonne, a chair of histology, to which M. Chatin has been assigned, and a second chair of physics, to which M. Pellat has been assigned. The chair of chemistry, vacant by the death of M. Friedel, has not been filled, but M. Chabrié is giving the courses.